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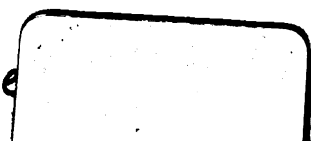
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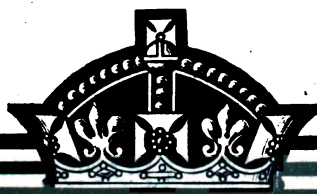
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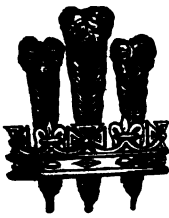
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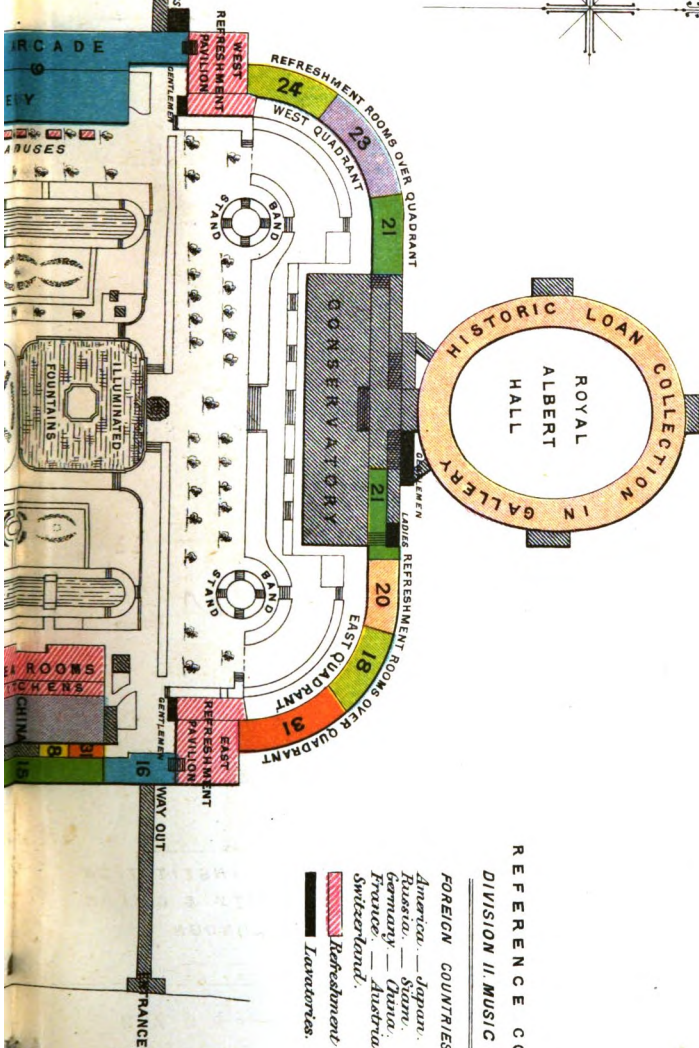
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- 12 Elements of Machines.
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- 15 Gas & other Illuminants.
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- 17 Food, Cookery & Stimulants.
- 18 Clothing.
- 19 Jewellery.
- 20 Leather &c.
- 21 India Rubber &c.
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- 23 Pottery & Glass.
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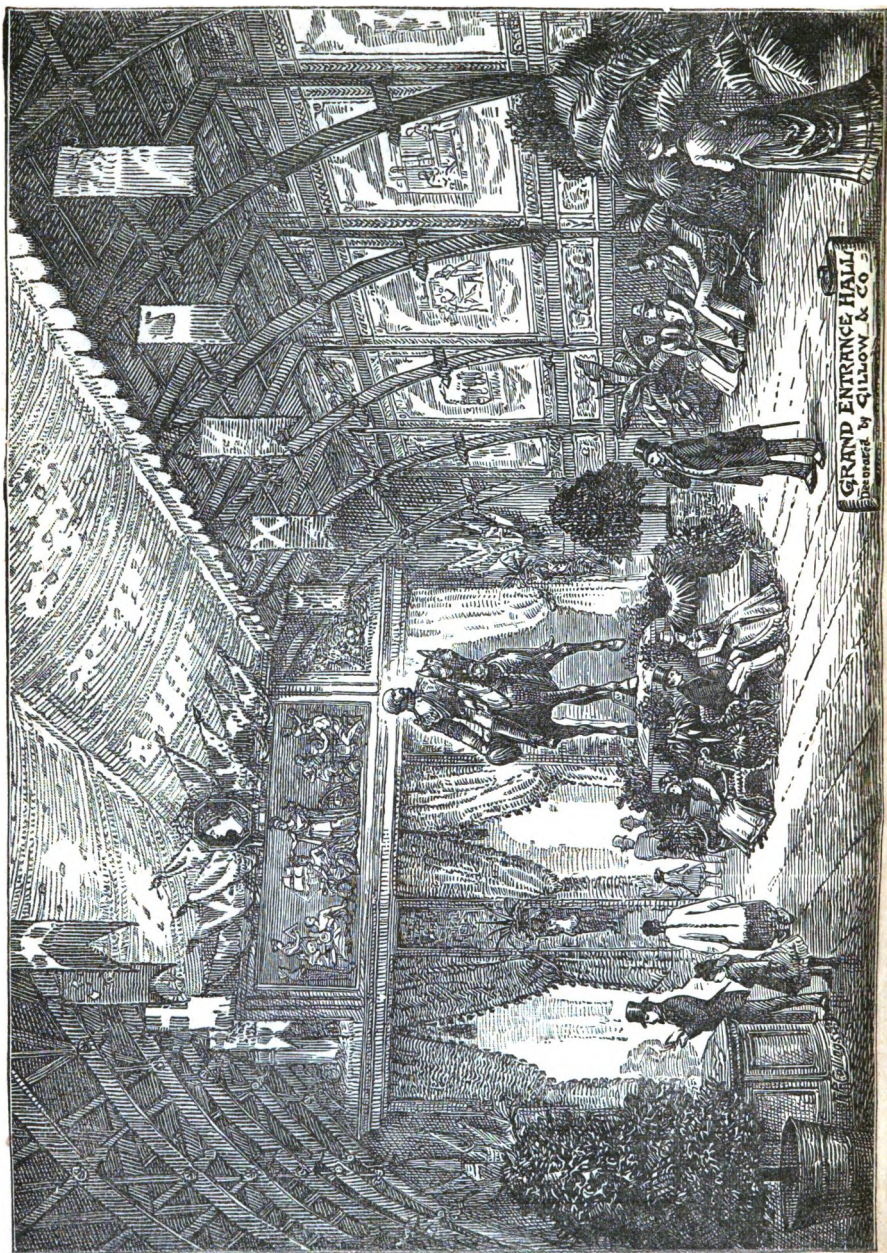


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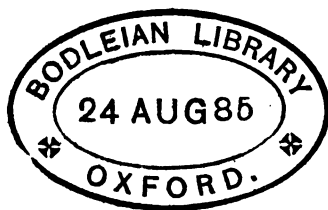
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REGULATIONS.

- Date.** 1. An International Inventions Exhibition, under the patronage of Her Majesty the Queen and the presidency of His Royal Highness the Prince of Wales, will be held in London in 1885.
- Open.** 2. The Exhibition will be opened in May 1885, and will continue open for a period of about six months.
- Objects."** 3. Division I. (Inventions) will be devoted to illustrations of Apparatus, Appliances, Processes and Products, invented or brought into use since 1862.
- Division II. (Music) will consist of examples of Musical Instruments of a date not earlier than the commencement of the present century; and of Historic Collections of Musical Instruments and Appliances, and Paintings, Engravings and Drawings representing Musical subjects, without any restriction as to date.
- Awards.** 4. Medals in Gold, Silver and Bronze, and Diplomas of Honour will be awarded on the recommendation of Juries.
- Expenses to be borne by Exhibitors.** 5. No charge will be made for space; but Exhibitors will have to pay every expense of conveying, delivering, fixing and removing their Exhibits; and also the cost of the erection of counters when required; and they must, either personally or by their Agents, superintend the dispatch, transmission, reception, unpacking, installation and (at the close of the Exhibition) the removal of their goods; in default thereof the Executive Council reserve to themselves the right of doing whatever may be considered necessary, at the expense of the Exhibitor.
- Delivery of goods.** 6. Should any goods be deposited in the Exhibition premises during the absence of the Exhibitor or his Agent, the Executive Council will not be responsible for any loss or damage, from whatsoever cause arising.
- Empty cases.** 7. Cases must be unpacked as fast as possible, and the empty cases taken away by the Exhibitors or their Agents. The Executive Council decline to accept any responsibility with reference to empty cases, which must be at once removed from the building at the expense of Exhibitors.
- Applications to exhibit.** 8. Applications to exhibit must be made on printed forms, which will be supplied on application to the Secretary, International Inventions Exhibition, South Kensington, S.W.; these must be filled up and returned on or before the 1st November, 1884. The decision of the Council with regard to applications will be notified about the 1st of December.

Right to
refuse
exhibits.
Manufactured
articles.

9. The Council reserve to themselves the absolute right of refusing to admit any exhibit without necessarily specifying any reason for so doing.

10. Manufactured articles or products will only be admitted in so far as they may be necessary to illustrate an improved method of manufacture, or an improvement in the machine or process by which they are produced.

Untried inventions.

11. Untried and unpatented inventions will not be accepted unless recommended by a competent authority.

Improved machines.

12. Where the invention relates to parts only of a machine, the whole machine will not be admitted unless the improvement (in respect of which the machine is offered for exhibition) cannot be sufficiently well shown without the exhibition of the entire apparatus, or unless in the opinion of the Executive Council the exhibit is of such special interest as to render its admission desirable.

Models.

13. Inasmuch as the scope of this Exhibition is very extensive, while the total area available is limited, it will be necessary to restrict as much as possible the space available for each Exhibitor. It will, therefore, generally be preferable that inventions should (as far as practicable) be illustrated by models, which in the case of an entire machine may be accompanied by actual examples of the parts improved.

Classification not exhaustive.

14. The classification is not to be considered as exhaustive. Where there appears to be no head under which an invention may come, the Exhibitor should apply for space in the group most nearly cognate.

Inventions under various groups.

15. In cases where an invention may come within the scope of several distinct groups, the Exhibitor is at liberty to enumerate the groups into which he considers it should come, in order that reference may be made to it in the different sections of the Catalogue; but duplicate exhibits will not be admitted.

Restrictions.

16. Except under special circumstances, no applications will be entertained for space for objects which have been shown in the Smoke Abatement Exhibition, 1881; the Fisheries Exhibition, 1883; or the Exhibition of Health and Education, 1884. The space allotted to Agricultural Exhibits will be very limited.

Railway rates.

17. The Executive Council will endeavour to obtain, from the various English Railway Companies, special terms for the conveyance of exhibits to and from the Exhibition; and, should they succeed in doing so, such arrangements will be communicated to intending Exhibitors.

Marks on packages.

18. All packages containing goods intended for exhibition must have painted on them the distinctive mark I. I. E., together with the name and address of the Exhibitor. Labels, addressed to the Secretary, to be attached to packages, will be forwarded to each Exhibitor.

Dimensions of cases, &c.

19. All cases, counters, platforms, &c., must not, without special permission, exceed the following dimensions:—

Show cases and partitions . . . 10 feet above the floor.

Counters 3 " " " "

Platforms 1 foot " " "

Railings. " 20. Exhibitors may place railings around their stands, subject to

approval ; but in every instance the railings must be within the area of the "stand," i.e., of the space allotted.

- Flooring.** 21. The flooring must not be altered, removed, or strengthened for the convenience of arrangement, except by sanction of the Executive Council, and at the expense of the Exhibitor.
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- Decorations.** 23. In order to ensure uniformity of decoration and general good effect, no Exhibitor will be allowed to put up any flags, banners, or other kind of decoration without special permission.
- Signs.** 24. Signs or name-boards must be placed parallel with the main passages, that is, parallel with the frontage of the respective stands ; and must in no case interfere with the lighting. They must be black with gold letters, and their position must be subject to the approval of the Executive Council.
- Handbills.** 25. All handbills, printed matter, &c., connected with exhibits, and intended for gratuitous distribution, must first receive the approval and permission of the Executive Council, which permission may be withdrawn at any time.
26. Exhibitors will be required to provide all necessary attendance and to keep their stands and exhibits properly cleaned and in good order during the whole period of the Exhibition.
- Non-transfer.** 27. No Exhibitor will be allowed to transfer any allotment, or portion thereof, or to allow any other than his own duly admitted exhibits to be placed thereon, except by permission of the Executive Council.
- Name.** 28. All goods exhibited must be in the name of the person who signed the application form.
- Selling price.** 29. Exhibitors are requested to mark the selling prices of the articles exhibited, so as to facilitate the judgment of the Juries, as well as for the information of visitors.
- Removal.** 30. Objects cannot be taken away before the close of the Exhibition, without the special permission in writing of the Executive Council.
- Selling.** 31. Exhibitors, or their attendants, may explain their exhibits to visitors, but they will in all cases be forbidden to invite visitors to purchase the goods, the Exhibition being intended for the purposes of display only, and not for those of sale. Special regulations will, however, be framed with regard to perishable articles.
- Motive power.** 32. Motive power will be supplied free of cost under certain conditions ; but Exhibitors will be required to pay for any gas or water that they may require. Exhibitors requiring motive power are requested to make special application to the Secretary.
- Dangerous substances.** 33. No explosive substances, nor any substances which in the judgment of the Executive Council are dangerous, will be admitted ; they may be represented by models or dummies.
- Spirits, &c.** 34. Spirits, oils, essences, corrosive substances, and generally all sub-

- stances which might spoil other articles or inconvenience the public, can only be received in substantial and suitable vessels of small size.
- Catalogue.** 35. The Executive Council reserve to themselves the sole right of compiling a catalogue of the exhibits under regulations which will be duly notified. Each nation will, however, have the right to produce at its own expense a catalogue of all the objects in its own Section.
- Testing and Analysing.** 36. The Executive Council reserve to themselves the right of causing any of the exhibits to be examined, tested or analysed for such objects as they may think fit.
- Photographing, &c.** 37. No article exhibited may be photographed, drawn, copied or reproduced, in any manner whatsoever, without the special sanction of the Exhibitor and of the Executive Council.
- Non-liability.** 38. The Executive Council will not hold themselves responsible for loss or damage occurring to any exhibit from any cause whatsoever; but, while declining any responsibility, the Council intend to take such precautions as they deem necessary.
- Date of reception.** 39. No goods can be sent in previous to the 1st of March without special permission; after the 15th of April no goods will be received.
- Passes.** 40. Passes to the Exhibition will be granted to Exhibitors and to a reasonable number of attendants. If these passes are used by any but those to whom they are issued, they will be immediately cancelled.
- Right to alter rules.** 41. The right to add to, alter, amend or expunge any of these Rules is reserved by the Executive Council.
- Rules binding.** 42. Both Englishmen and Foreigners in becoming Exhibitors signify by so doing their compliance with the whole of these Regulations, together with such other Regulations as the Executive Council may issue from time to time.
- Right of removal.** 43. The Executive Council reserve the right to remove the objects belonging to any Exhibitor who may not conform to the Regulations.
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SPECIAL RULES (IN ADDITION TO THE ABOVE) AFFECTING FOREIGN AND COLONIAL EXHIBITORS.

- Foreign Commissioners.** 45. The Foreign and Colonial Commissioners appointed by their Governments are invited to communicate with the Secretary. They will

be charged with the consideration of all questions relative to the distribution of the space allotted to their respective countries; and the Executive Council will place at their disposal all information and plans that may be useful to them. Foreign and Colonial Commissioners will be required to guarantee that all exhibits in their respective sections are in accordance with the Classification and with the Regulations.

Foreign
countries.

46. The applicants for space from countries in which no Commissioner has been nominated must appoint Agents in England to act on their behalf.

47. Applications from Foreign Countries and Colonies will be received up to the 1st of December.

Foreign
packages.

48. Packages from Foreign Countries must have painted on them the letters I. I. E. They must all be marked in such a way as to show distinctly from whence they come, the name of the country, and the name and address of the Exhibitor.

**LIST OF GROUPS UNDER WHICH THE CLASSIFICATION IS
ARRANGED.**

**DIVISION I.—APPARATUS, APPLIANCES, PROCESSES, AND PRO-
DUCTS, INVENTED OR BROUGHT INTO USE SINCE 1862.**

- 1.—AGRICULTURE, HORTICULTURE AND ARBORICULTURE.
- 2.—MINING AND METALLURGY.
- 3.—ENGINEERING CONSTRUCTION AND ARCHITECTURE.
- 4.—PRIME MOVERS, AND MEANS OF DISTRIBUTING THEIR POWER.
- 5.—RAILWAY PLANT.
- 6.—COMMON ROAD CARRIAGES, &c.
- 7.—NAVAL ARCHITECTURE.
- 8.—AERONAUTICS.
- 9.—MANUFACTURE OF TEXTILE FABRICS.
- 10.—MACHINE TOOLS AND MACHINERY.
- 11.—HYDRAULIC MACHINES, PRESSES, MACHINES FOR RAISING HEAVY WEIGHTS,
WEIGHING, &c.
- 12.—ELEMENTS OF MACHINES.
- 13.—ELECTRICITY.
- 14.—APPARATUS, PROCESSES, AND APPLIANCES CONNECTED WITH APPLIED CHEMISTRY
AND PHYSICS.
- 15.—GAS AND OTHER ILLUMINANTS.
- 16.—FUEL, FURNACES, &c.
- 17.—FOOD, COOKERY AND STIMULANTS.
- 18.—CLOTHING.
- 19.—JEWELLERY.
- 20.—LEATHER, &c.
- 21.—INDIA-RUBBER AND GUTTA-PERCHA, &c.
- 22.—FURNITURE AND ACCESSORIES—FANCY GOODS.
- 23.—POTTERY AND GLASS.
- 24.—CUTLERY, IRONMONGERY, &c.
- 25.—FIRE-ARMS: MILITARY WEAPONS AND EQUIPMENT; EXPLOSIVES.
- 26.—PAPER, PRINTING, BOOKBINDING, STATIONERY, &c.
- 27.—CLOCKS, WATCHES, AND OTHER TIME-KEEPERS.
- 28.—PHILOSOPHICAL INSTRUMENTS AND APPARATUS.
- 29.—PHOTOGRAPHY.
- 30.—EDUCATIONAL APPARATUS.
- 31.—TOYS, SPORTS, &c.

DIVISION II.—MUSIC.

- 32.—INSTRUMENTS AND APPLIANCES CONSTRUCTED OR IN USE SINCE 1800.
- 33.—MUSIC ENGRAVING AND PRINTING, MODERN PAINTINGS, &c.
- 34.—HISTORIC COLLECTIONS.

CLASSIFICATION.

NOTE.

The heads given below are not intended to be exhaustive, but are rather to be regarded as indicative of the proposed scope of each class.

Only under exceptional circumstances can applications be entertained for space for objects which have been shown in the Smoke Abatement Exhibition, 1881; the Fisheries Exhibition, 1883; or the Exhibition of Health and Education, 1884, or for Agricultural Implements. The space allotted to those Classes marked with an asterisk will therefore be very limited.

DIVISION I.—APPARATUS, APPLIANCES, PROCESSES, AND PRODUCTS, INVENTED OR BROUGHT INTO USE SINCE 1862.

Group I.—AGRICULTURE, HORTICULTURE AND ARBORICULTURE.

(For land drainage, reclamation, &c., see Group iii.; for agricultural engines, see Group iv.; for manure, see Group xiv.; for milling machinery, see Group xvii.)

- *CLASS 1. FIELD IMPLEMENTS.—Ploughs, drain-ploughs, cultivators, steam-diggers, harrows, drills, haymakers, horse-hoes, rakes, reapers, mowers, binders, anchors and rope porters, wagons, wagon-harness.
- * „ 2. BARN AND FARM-YARD IMPLEMENTS.—Thrashing machines, screens, winnowers, corn-cleaning machines, hay and straw elevators, hay and straw and fresh fodder compressors, turnip-cutters, chaff-cutters, grist mills, horse-gear, crop dryers.
- * „ 3. DAIRY AND POULTRY-FARM APPLIANCES.—Milking appliances, cream separators, churns, cheese-making apparatus, apparatus for manufacturing butterine, incubators.
- * „ 4. AGRICULTURAL CONSTRUCTION.—Models, plans and designs for farm buildings, oast houses, siloes, rickstands, &c.
- * „ 5. CATTLE FOOD.—Materials, processes, apparatus; seed mills, cake crushers; boilers, steamers and cooking apparatus; feeding appliances.

CLASS 6. HORTICULTURAL APPARATUS.—Hot-houses, frames, greenhouses, orchard houses, graperies, boiler and heating apparatus, lawn mowers, watering apparatus, tools and implements, pots and plant boxes, garden wire-work, chairs, &c., plant labels.

„ 7. ARBORICULTURE.—Apparatus, &c., used in forestry; methods and materials for the preservation from decay of trees and timber.

Group II.—MINING AND METALLURGY.

(For stone-working machinery and testing machines, *see* Group x.; for metal-working machinery, *see* Group x.; for slate sawing and dressing machines, *see also* Group x.; for electrolytic methods of extracting, &c., metals, *see* Group xiii.; for furnaces in general, *see* Group xvi.; for manufacture of fuel, *see also* Group xvi.; for explosives, *see also* Group xxv.; for mine-surveying apparatus, *see also* Group xxviii.)

CLASS 8. MACHINERY AND APPLIANCES USED IN MINES AND QUARRIES.—

Prospecting, searching, boring, shaft sinking, exploring, working, hauling, pumping, winding, hoisting; man engines, safety catches, safety hooks, hydraulic mining; tools, drills, cutters, getters, breakers, air compressors; blasting, substitutes for explosives. Ventilating, lighting. Aids to respiration in mines. Life-saving appliances. Washing and dressing coal and other minerals, crushers, pulverisers, disintegrators, stamps, screens, riddles, separators, classifiers, jiggers, buddles, precipitators, sawing-machines. Utilisation of waste.

„ 9. PRODUCTION AND MANUFACTURE OF IRON AND STEEL.—Coke ovens, blast and other furnaces; Bessemer plant, Siemens plant, other processes for making iron and steel; blast engines; hot-blast stoves; steam and other hammers; rolling machines, hydraulic and other forging machines, squeezers and other shingling apparatus; production and use of malleable cast iron; wire-making apparatus; manufacture of tin plate, utilisation of gases and of slag; alloys and artificial compounds of iron with non-metallic elements.

„ 10. FORGING AND FOUNDRY WORK.—Cupolas, air furnaces, pot furnaces; moulding machines, plate-moulding; forges, forging machines; blowers, bellows, fans.

„ 11. METALLURGY OF METALS OTHER THAN IRON, WITH THE EXCEPTION OF THE PRECIOUS METALS. ALLOYS.—Furnaces and appliances used in the dry and wet methods of extracting and purifying copper; extraction of lead; metallurgy of zinc, tin, nickel, cobalt, bismuth, antimony, arsenic, mercury, aluminium; manufacture of sheet lead, lead pipe, Muntz's metal, sheet zinc, copper and brass tubes; bronzes, German silver and other nickel alloys; wires of copper and its alloys.

„ 12. METALLURGY OF THE PRECIOUS METALS, GOLD, SILVER AND PLATINUM.—Furnaces and appliances used in the dry and wet methods of extracting the precious metals; desilverisation of lead; amalgamation in all its forms, refining gold and silver; purification, melting and working of platinum and its alloys.

Group III.—ENGINEERING CONSTRUCTION AND ARCHITECTURE.
 (For railway plant, *see* Group v.; for launching ships, *see* Group vii.; for surveying instruments, *see* Group xxviii.)

- CLASS 13. ROADS.**—Methods and materials for constructing and paving roads; cleansing roads and pavements; road-sweeping machines; rollers; apparatus for the removal of mud, snow, &c.; water-carts and other means of watering.
- „ **14. RAILWAYS AND TRAMWAYS.**—Construction; excavators and appliances used for earth-work and tunnelling. Permanent way; rails, chairs, sleepers.
- „ **15. BRIDGES AND VIADUCTS.**—Models, plans, and designs for arched, girder, suspension, trestle, and other bridges; apparatus used in construction.
- * „ **16. DOCKS AND HARBOURS.**—Models, plans, and designs for docks, harbours, piers, breakwaters, &c.; submarine constructions; diving apparatus; dredging machines; pile-drivers, screw piles; coffer-dams; graving docks, “patent” slips, caissons, pontoons, floating docks, hydraulic apparatus for working dock-gates, &c., gridirons. Buoys.
- * „ **17. LIGHTHOUSES.**—Methods of construction; appliances used in light houses and in lightships, fixed and flashing light apparatus, lamps, sound signalling apparatus.
- „ **18. RIVERS AND CANALS.**—Conservation and improvement of rivers; construction of canals; locks, lifts and inclines, weirs.
- * „ **19. WATER SUPPLY AND SEWERAGE.**—Methods of collecting, pumping, storing, filtering, and distributing water; appliances for detecting and preventing waste of water, water-meters; water fittings, filters; sewers, sewage disposal and utilisation.
- „ **20. RECLAMATION, IRRIGATION AND DRAINAGE OF LAND.**—Drainage (natural and artificial) of low-lying districts; embanking and warping land; irrigation works.
- „ **21. TESTING APPARATUS.**—Apparatus and instruments used in testing iron, stone, brick, concrete, cement, &c.
- „ **22. MILITARY ENGINEERING AND FORTIFICATION.**—Military topography.
- * „ **23. MATERIALS USED IN BUILDING.**—Bricks and tiles, machines for making them; concrete, artificial stone, cement, materials and appliances used in their production; asphalt; roofing felt, and other roofing materials; columns, girders, and other application of metal in building; applications of terra-cotta to buildings; preservative and fire-resisting materials, paints, &c., for application to stone, wood, iron, &c.; methods of applying the same.
- * „ **24. BUILDING CONSTRUCTION.**—Models and plans showing methods of construction; non-combustible constructions; labour saving and other machines and appliances used in building, scaffolds, elevators fittings and appliances used in buildings, shutters, blinds, lifts, bells, speaking-tubes, &c.

- * CLASS 25. HEATING, VENTILATION, HOUSE-DRAINAGE, &c.—Sanitary appliances; ventilators; cowls for chimneys, chimney-sweeping apparatus; apparatus for heating by steam, water, air, &c.; means of cooling air.

Group IV.—PRIME MOVERS, AND MEANS OF DISTRIBUTING THEIR POWER.

(For distribution of power by water, *see also* Group xi.; by electricity, *see* Group xiii.)

CLASS 26. STEAM-ENGINES AND BOILERS.—Stationary, portable, marine, locomotive; fireless locomotives; methods and means of preventing corrosion and incrustation; methods and appliances for preventing explosions, and for testing boilers; firegrates, fire-feeders, smoke-consuming appliances; valves and valve gear, steam joints, governors, injectors, pumps; bearings, lubricators, anti-friction metals; indicators, gauges, manometers, tachometers, dynamometers.

„ 27. GAS AND AIR ENGINES, &c.—Gas-engines, hot-air engines, petroleum-engines; air-compressors, compressed air-engines; ammonia-engines, vapour-engines; accessories for the above.

„ 28. MEANS OF UTILISING NATURAL FORCES.—Turbines, water-wheels, tide-mills; means of utilising wave-power; hydraulic rams, water-pressure engines; windmills; solar engines.

„ 29. MEANS OF TRANSMITTING POWER.—Driving bands, shafts, pulleys, gearing, clutches, distribution of power by water or by air.

Group V.—RAILWAY PLANT.

(For construction of railways and tramways, *see* Group iii.; for locomotives, *see* Group iv.; for common road locomotives, *see* Group vi.; for signals, *see also* Group xiii.)

CLASS 30. ROLLING STOCK (EXCEPTING LOCOMOTIVES).—Carriages, trucks, wagons, vans, wheels, tyres, axles, springs, bearings, buffers, couplings.

„ 31. FIXED AND OTHER APPLIANCES.—Switches, signals, crossings, turntables, switch-locks, communication with trains and in trains, water cranes, and other modes of tender supply.

„ 32. BRAKES, HAND AND AUTOMATIC.—Screw, chain, compressed air, vacuum, steam, electrical.

„ 33. TRAMWAYS.—Rolling and fixed plant.

„ 34. ATMOSPHERIC RAILWAYS, PORTABLE RAILWAYS, &c.—Rope railways, pneumatic dispatch.

Group VI.—COMMON ROAD CARRIAGES, &c.

(For farm wagons, &c., *see* Group i.)

CLASS 35. CARRIAGES FOR COMMON ROADS.—Steam, &c., carriages; pleasure and travelling carriages; cabs, omnibuses, hearses, trucks, carts, bath chairs, perambulators, ambulance carriages; machinery used in carriage, &c., construction; indicators, carriage lamps, carriage furniture and fittings; methods and means of propulsion.

- CLASS 36. BICYCLES AND TRI CYCLES.**—"Cycles" of every description, and fittings for the same.
- „ 37. **SADDLERY AND HARNESS.**—Horse-clothing, whips, spurs; means and methods of breaking in horses; disengaging runaway horses.
- „ 38. **FABRIERY.**—Veterinary apparatus and material; medicines for horses, cattle, &c.; horse-shoes, machinery for making horse-shoes and horse-nails; methods of roughing horses; horse-clippers; grooming apparatus.

Group VII.—NAVAL ARCHITECTURE.

(For floating docks and dredging apparatus, *see* Group iii.; for engines and marine engines, *see* Group iv.; for nautical instruments, *see* Group xxvii.)

- * **CLASS 39. SHIP AND BOAT BUILDING.**—Construction and materials; sheathing armour-plating, launching; cleaning ships' bottoms, preventing, fouling; raising sunken vessels, leak-stoppers, life-boats, life-rafts and fittings, life-saving apparatus; light-ships; submarine boats, torpedo boats; loading and discharging cargo.
- * „ 40. **SHIPS' FITTINGS.**—Masts, sails, rigging, &c.; materials for sails; wire-rigging; self-reefing sails; use of steam power for working sails; anchors, and chain cables; means for weighing anchor; steam winches, capstans; lowering ships' boats; pumping and ventilating arrangements.
- „ 41. **MARINE PROPULSION (INCLUDING STEERING).**—Screw propellers, paddles, hydraulic propellers, river and canal propulsion, chain towing; hand, steam, and hydraulic steering gear.

Group VIII.—AERONAUTICS.

(For observing instruments, *see* Group xxviii.; for apparatus for balloon photography, *see* Group xxix.)

- CLASS 42. BALLOONS.**—Materials for balloons; methods of constructing and inflating; manufacture and transport of gas for the purpose; fittings; military and captive balloons; balloon equipment for field and siege purposes; fire-balloons; parachutes.
- „ 43. **AERONAUTIC APPARATUS.**—Flying machines; propelling and steering apparatus for such machines.

Group IX.—MANUFACTURE OF TEXTILE FABRICS.

(For dyes, mordants, &c., *see* Group xiv.)

- CLASS 44. TREATING RAW MATERIAL.**—Cotton—picking, ginning, seed-cleaning, baling, pressing, opening. Flax, jute, rheca, &c.—retting and its substitutes, breaking, scutching, heckling. Wool—clipping, sorting, washing, drying, heckling. Silk—rearing and feeding of silkworms, reeling, winding, loading, conditioning.
- „ 45. **PREPARING FOR SPINNING.**—Combing and carding fibrous materials manufacture of combs and cards.

- CLASS 46. SPINNING.**—Drawing, slubbing, roving, spinning, twisting, doubling, throwing, spooling, reeling, balling, &c. Making sewing and darning thread; reels, cops, and cop tubes.
- „ **47. PREPARING FOR WEAVING.**—Sizing, warping, beaming, &c., yarns.
- „ **48. WEAVING.**—Weaving plain, figured, damask, and double fabrics; weaving carpets, velvets, and other pile and terry fabrics; weaving ribbons, tapes, &c., hose for water, sacks, sailcloth, hair; jacquards and apparatus for making jacquard cards, electrical and other substitutes; temples, pickers, including pneumatic and modes of “handing” shuttles; harness, healds and reeds, weft and other stoppers.
- „ **49. RUG AND MAT MAKING.**—Cocoa-nut and other fibre.
- „ **50. LACE-MAKING, &c.**—Manufacture of lace, knitted fabrics, hosiery, &c., net and meshed fabrics, nets, fringes, chenille, braid and plaited fabrics, elastic fabrics.
- „ **51. DRESSING AND FINISHING.**—Drying, stretching, ageing, dressing, finishing, singeing, shearing, folding, fulling, calendering, measuring, packing, and otherwise preparing for market.
- „ **52. FELT-MAKING.**—Manufacture of felted fabrics.
- „ **53. BLEACHING AND TISSUE PRINTING.**—Machines and Appliances used in bleaching, dyeing, and printing fibres, yarns, and fabrics; mixtures used in bleaching and washing, dyeing, patterns; resist and discharge printing; printing rollers and blocks. Dyeing materials and colours; thickeners.
- „ **54. ROPE-MAKING.**—Manufacture of twine, cord, rope, safety fuses; materials used in the manufacture.
- „ **55. UTILISATION OF SECOND-HAND MATERIALS AND WASTE PRODUCTS.**—Mungo, shoddy, tow, oakum, waste silk, waste cotton.

Group X.—MACHINE TOOLS AND MACHINERY.

(For steam-hammers and forging machinery used in iron and steel making, *see* Group ii.; for machines for making horse-shoes and horse-nails, *see also* Group vi.)

- CLASS 56. METAL-WORKING MACHINES.**—Lathes; planers; machines for punching, shearing, sawing, drilling, boring, slotting, shaping, milling, wheel-cutting, screw-cutting, rolling and bending, corrugating, stamping, coining, pressing, riveting, forging; emery wheels, grinding machines; rivet, nail, bolt, and screw-making machinery.
- „ **57. WOOD-WORKING MACHINERY.**—Lathes (including lathes for ornamental turning); machines for sawing, planing, moulding, mortising, carving, veneering, cask-making, wheel-making, cork-cutting, &c.
- „ **58. STONE-WORKING MACHINERY.**—Machines for sawing, planing, turning, dressing, polishing, grinding, breaking and crushing stone and slate.

Group XI.—HYDRAULIC MACHINES, PRESSES, MACHINES FOR RAISING HEAVY WEIGHTS, WEIGHING, &c.

(For hay and straw elevators, *see* Group i.; for elevators used in building, *see* Group iii.; for hydraulic rams, *see* Group iv.; for grain elevators, *see* Group xvii.; for chemical, &c., balances, *see* Group xxviii.)

CLASS 59. PUMPS, HAND, STEAM, ROTARY, CENTRIFUGAL.—Ships' pumps, pumps for corrosive fluids; hydropulps; syphons; methods of raising water; methods of obtaining, distributing, and equalising hydraulic power; accumulators.

* „ 60. FIRE-ENGINES.—Fire-extinguishing apparatus; automatic apparatus for indicating and extinguishing fires; fire-escapes, ladders, fire hose, accessory fittings and appliances; hydrants.

„ 61. CRANES AND OTHER LIFTING APPARATUS.—Hand, steam, and hydraulic cranes; travellers; elevators, jacks, capstans, windlasses, crabs, hoists, blocks, pulleys, derricks.

„ 62. HYDRAULIC AND OTHER PRESSES.

„ 63. WEIGHING MACHINES (FOR COMMERCIAL PURPOSES).—Steel-yards; platform weighing machines; commercial balances, scales, weights &c.; registering weighing machines; spring balances.

Group XII.—ELEMENTS OF MACHINES.

CLASS 64. MECHANICAL MOVEMENTS.

„ 65. SEPARATE PARTS OF MACHINES.

Group XIII.—ELECTRICITY.

(For railway signals, *see* Group v.; for photometers, *see* Groups xv. and xxviii.; for scientific apparatus used in electrical research, *see* Group xxviii.)

CLASS 66. GENERATORS.—Dynamoes, primary and secondary batteries, thermo-electric batteries.

„ 67. CONDUCTORS.—Submarine cables and apparatus for laying them; aerial wires, and underground cables; insulators and poles; insulating and coating materials; joints and connections; underground conduits; pipes, tubes, troughs, &c., electric light leads.

„ 68. TESTING AND MEASURING APPARATUS.—Galvanometers, magnetometers, dynamometers, volt-meters, current-meters, methods of testing.

„ 69. TELEGRAPHIC AND TELEPHONIC APPARATUS.—Needle instruments, A B C instruments, Morse instruments, type-printers, relays, duplex and quadruplex apparatus, keys, recording instruments, automatic transmitters, electric bells, indicators, telephones, microphones, lightning protectors.

„ 70. ELECTRIC LIGHTING APPARATUS.—Lamps, resistance coils, cut-outs, safety catches, switches. Fittings for glow and other lamps.

- CLASS 71. ELECTRO-METALLURGY AND ELECTRO-CHEMISTRY.**—Methods of depositing and coating various metals. Electrotyping, galvanoplasty. Vats, cleaning and polishing apparatus, materials, tools, and appliances.
- „ **72. DISTRIBUTION AND UTILISATION OF POWER.**—Electric railways, electric motors, electrically driven boats, tricycles, and other conveyances; systems of distribution.
- „ **73. ELECTRIC SIGNALLING.**—Fire and burglar alarms, railway, ship, and time signals, water-level and wind indicators, tell-tales, electric clocks, chronoscopes, &c.
- „ **74. LIGHTNING CONDUCTORS.**
- „ **75. ELECTRO-MEDICAL APPARATUS.**
- „ **76. ELECTROLYTIC METHODS FOR EXTRACTING AND PURIFYING METALS.** Copper, zinc, lead, iron, refining the precious metals.
- 77. ELECTRO-THERMIC APPARATUS.**—Electrical apparatus for war, mining, blasting, and other purposes.

Group XIV.—APPARATUS, PROCESSES, AND APPLIANCES CONNECTED WITH APPLIED CHEMISTRY AND PHYSICS.

(For chemical apparatus used in scientific research, *see* Group xxviii.)

- CLASS 78. INORGANIC PRODUCTS, AND MEANS USED IN OBTAINING THEM.**—Sulphuric and other acids, ammonia and other alkalis, bleaching agents, dye and dye-stuffs, salts, white-lead, paints and pigments, phosphorus, lucifer matches, disinfectants.
- „ **79. ORGANIC AND SYNTHETICAL PRODUCTS, AND MEANS USED IN OBTAINING THEM.**—Coal-tar products, oils, soaps, and detergents, lubricating agents, perfumery, paraffin, varnishes, manures.
- „ **80. APPARATUS AND APPLIANCES FOR COMPRESSING AND LIQUEFYING GASES, AND APPLICATIONS THEREOF.**

Group XV.—GAS AND OTHER ILLUMINANTS.

(For electric lighting, *see* Group xiii.; for gas-stoves, *see* Group xvi.; for photometrical apparatus, *see also* Group xxviii.)

- CLASS 81. COAL GAS.**—Manufacture, purification, storage and distribution of gas; treatment of residues.
- „ **82. WATER GAS, OIL GAS, CARBURETTING AIR, &c.**
- „ **83. TESTS AND PHOTOMETRICAL APPARATUS.**—Chemical tests; standards of light; measurement of light.
- „ **84. BURNERS, AND MEANS OF UTILISING AND APPLYING GAS.**—Gas fittings; burners for illuminating gas; devices for imparting luminosity to flame; gas meters; methods of lighting gas; methods of increasing illuminating power of gas.
- „ **85. MINERAL AND OTHER OILS.**—Methods of obtaining; distilling and refining, testing.
- „ **86. CANDLES, &c.**—Candles of wax, tallow sperm, paraffin, &c.; night-lights; appliances used in the manufacture.
- „ **87. LAMPS FOR OIL AND SPIRITS, HOLDERS FOR CANDLES, &c.**

Group XVI.—FUEL, FURNACES, &c.

(For coke ovens and metallurgical furnaces, *see* Group ii.; for glass, &c., furnaces, *see* Group xxiii.)

CLASS 88. **MANUFACTURE OF FUEL.**—Materials and processes for the manufacture of artificial fuel; preparation and use of liquid fuel; preparation of peat; charcoal burning.

„ 89. **FURNACES FOR MANUFACTURING PURPOSES.**—Furnaces for burning solid, pulverised, liquid and gaseous fuel.

* „ 90. **STOVES FOR COAL, FOR GAS, FOR OIL, &c.**—Cooking stoves and kitchen ranges; domestic fireplaces; gas cookers; gas burners for heating and cooking; petroleum and other stoves for heating and cooking.

Group XVII.—FOOD, COOKERY AND STIMULANTS.

(For the cooking of cattle food, *see* Group i.)

CLASS 91. **MACHINERY FOR TREATING GRAIN AND FLOUR.**—Machines for preparing and grinding corn and dressing flour, and other mill machinery; mill-stone dressers, roll-turners, and similar machines; machines for milling and polishing rice; grain elevators; apparatus for drying grain; granary fittings.

* „ 92. **MANUFACTURING ARTICLES OF FOOD.**—Apparatus for manufacturing and refining sugar; confectioners' machinery; machines and appliances for preparing mustard, spice, pepper, &c.; manufacture of salt.

* „ 93. **PRESERVING FOOD.**—Methods, materials and processes for preserving animal and vegetable food; machines for producing cold.

* „ 94. **BREAD AND BISCUIT MAKING.**—Kneading machines, biscuit and bread-making machines, ovens; processes for making bread.

* „ 95. **COOKING APPARATUS.**—Culinary utensils, chopping and mincing machines; apparatus for paring and slicing fruit and vegetables, cleaning fruit, washing and cleaning vegetables.

„ 96. **BREWING, DISTILLING, AND WINE-MAKING.**—Machines and appliances connected with the manufacture and use of alcoholic drinks.

* „ 97. **MANUFACTURE OF AERATED WATERS.**—Machinery, materials, &c., used for the purpose; stoppers and other appliances.

* „ 98. **INFUSIONS.**—Apparatus, &c., used in the preparation and use of tea, coffee, chocolate, &c.

* „ 99. **TOBACCO.**—Machinery, appliances, and processes for treating and using tobacco.

Group XVIII.—CLOTHING.

(For textile machinery, *see* Group ix.; for jewellery, &c., *see* Group xix.; for waterproof clothing, *see* Group xxi.)

* CLASS 100. **FABRICS.**—Specimens of new materials, or materials recently applied to the manufacture of clothing.

* „ 101. **ARTICLES OF CLOTHING.**—Specimens of clothing of novel construction.

- * **CLASS 102. MACHINERY AND APPARATUS.**—Machinery, &c., used in the production of articles of dress, sewing machines, knitting machines; machinery for the manufacture of boots, hats, gloves, &c. needles, and machinery employed in making them.
- * „ **103. CLEANING CLOTHING.**—Washing and wringing machines, mangling, &c., machines; boot-cleaning machines; machines and processes for cleaning other articles of clothing.
- * „ **104. DRESS FASTENINGS, &c.**—Buttons, pins, hooks and eyes, machinery employed in their manufacture.

Group XIX.—JEWELLERY.

CLASS 105. JEWELLERY AND PERSONAL ORNAMENTS.—Materials, apparatus for manufacture, &c.

Group XX.—LEATHER, &c.

(For saddlery, *see* Group vi.; for boots and shoes, *see* Group xviii.)

- CLASS 106. MANUFACTURE OF LEATHER.**—Materials, processes and appliances for cleaning, curing, preserving, unhairing, drying, tanning dyeing, splitting, dressing, and otherwise preparing skins and hides; specimens of leather prepared by new processes; manufacture of parchment.
- „ **107. TREATMENT AND APPLICATION OF LEATHER (EXCLUSIVE OF SADDLERY AND OF BOOTS AND SHOES).**—Methods of ornamenting, painting, polishing, staining, water-proofing, &c., leather.
- „ **108. ARTIFICIAL LEATHER, &c.**—Imitation leather, waterproof canvas, and tarpaulin.

Group XXI.—INDIA-RUBBER AND GUTTA-PERCHA, &c.

(For use of gutta-percha, &c., in electrical insulation, *see* Group xiii.; for artificial leather, *see* Group xx.; for kamptulicon, *see also* Group xxii.)

- CLASS 109. MACHINERY FOR TREATING INDIA-RUBBER AND GUTTA-PERCHA.**—Washing machines, rasps, masticators, mixing machines, vulcanisers, spreading machines, thread-making machines, wire-covering machines; machines for manufacturing rubber goods, pressers, moulds, &c.; appliances for stereotyping in rubber.
- „ **110. APPLICATIONS OF INDIA-RUBBER AND GUTTA-PERCHA.**—Waterproof goods; elastic webbing; articles of unvulcanised and vulcanised rubber and gutta-percha, and fabrics prepared therewith; ebonite, vulcanite, and articles made therefrom; complex or insertion goods; kamptulicon, &c.; cements; grinding wheels; bottle-stoppers; printing rollers.
- „ **111. SUBSTITUTES FOR INDIA-RUBBER AND GUTTA-PERCHA, MATERIALS USED IN THEIR TREATMENT, &c.**—Natural substances available as substitutes; artificial substitutes; combinations of rubber or gutta-percha with other materials; rubber, &c., from new sources of supply; pigments, solvents, &c., used in the manufacture; celluloid and other preparations of nitrated cellulose.

Group XXII.—FURNITURE AND ACCESSORIES—FANCY GOODS.

(For bronzes and alloys, *see* Group ii.; for household fixtures, *see also* Group iii.; for manufacture of carpets, *see* Group ix.; for rug and mat making, *see also* Group ix.; for glass and china, *see* Group xxiii.; for paper hangings, *see* Group xxvi.)

*CLASS 112. FURNITURE AND UPHOLSTERY.—Articles of furniture; machinery and processes used in their production; frames for pictures and mirrors; safes.

* „ 113. FLOOR-COVERINGS AND WALL-COVERINGS (OTHER THAN PAPER-HANGINGS).—Oil-cloth; linoleum, kamptulicon; mats and matting; material, appliances, and processes used in their manufacture.

„ 114. ARTISTIC AND ORNAMENTAL METAL-WORK.—Goldsmiths' and silversmiths' work; electro-plate; ornamental bronzes; appliances used in the manufacture.

„ 115. TRUNKS, PORTMANTEAUX, &c.—Dressing bags and cases; ivory, horn and bone goods; travelling equipments.

„ 116. BASKET-WORK.—Appliances for use in the manufacture.

„ 117. BRUSHES.—Materials, machines and appliances used in the manufacture; methods of brush-making.

„ 118. UMBRELLAS, PARASOLS, AND WALKING STICKS.—Machinery, &c., used in their manufacture.

Group XXIII.—POTTERY AND GLASS.

(For optical glass, *see* Group xxviii.; for glass apparatus, *see* Group xxviii.)

CLASS 119. KILNS AND FURNACES.

„ 120. BRICKS, TILES, EARTHENWARE, &c.—Terra-cotta; architectural pottery; fire-clay goods; crucibles; drain-pipes; chemical and similar stoneware; materials, machinery, and apparatus.

„ 121. PORCELAIN, MAJOLICA, AND ARTISTIC POTTERY.—Biscuit ware faience; Parian; materials, machinery, and apparatus.

„ 122. CROWN, SHEET, AND PLATE GLASS.—Window glass, mirrors, stained glass; glass mosaic; materials, machinery, and apparatus.

„ 123. BOTTLES, TABLE GLASS, TOUGHENED GLASS, &c.—Materials, machinery, and apparatus.

Group XXIV.—CUTLERY, IRONMONGERY, &c.

(For nail and screw-making machinery, *see* Group x.)

CLASS 124. CUTLERY AND TOOLS.—Engineers', carpenters', joiners', &c., tools.

„ 125. SURGICAL INSTRUMENTS AND APPLIANCES.

„ 126. FILES AND RASPS.—File-cutting machines.

„ 127. HARDWARE.—Hollow ware; ornamental castings; locks and bolts.

„ 128. SCREWS, NAILS, &c.—Spikes, hinges; furniture fittings.

Group XXV.—FIRE-ARMS, MILITARY WEAPONS AND EQUIPMENT EXPLOSIVES.*

(For fortification, *see* Group iii.; for torpedo boats, *see* Group vii.; for special articles mentioned under "military equipments," *see also* respective classes.)

- CLASS 129. ORDNANCE.—Heavy guns and means of working them; carriages and accessories; naval, siege, field, and mountain guns; machine guns; mitrailleuses; shells, and apparatus for their manufacture; apparatus used in testing, in measuring velocity, pressures, recoil, &c.
- „ 130. FUSES, DETONATORS.—Appliances for firing guns, and for exploding shells, signal lights, war and signal rockets, life-saving rockets.
- „ 131. GUNS, RIFLES, PISTOLS.—Military and sporting guns and rifles; revolvers; magazine guns; harpoon guns; air guns; machinery used in the manufacture of small arms; proving apparatus; targets.
- „ 132. SWORDS, BAYONETS, SAPPERS' TOOLS, &c.—Entrenching tools; shields; lances; dirks.
- „ 133. GUNPOWDER AND AMMUNITION.—Explosives generally, and apparatus used in their manufacture and testing; cartridges; cartridge cases.
- „ 134. TORPEDOES.—Submarine and subterranean torpedoes and mines, methods of laying, firing, and removing the same; naval torpedoes, means of carrying, projecting and firing the same.
- „ 135. TELEMETERS.—Range-finders for artillery and submarine mine service.
- * „ 136. MILITARY EQUIPMENT.—Photographic, telegraphic, pontoon, mining, signalling, hospital equipment; transport service.

* Explosive substances will under no circumstances be admitted. They must be represented by dummies or models.

Group XXVI.—PAPER, PRINTING, BOOKBINDING, STATIONERY, &c.

(For applications of photography to printing, *see also* Group xxix.)

- CLASS 137. MACHINES AND PROCESSES FOR THE MANUFACTURE OF PAPER, PASTE-BOARD AND PAPIER MÂCHÉ.—Materials; manufacture of "half-stuff"; washing, beating, and bleaching engines; agitators, strainers, moulds; methods, &c., of glazing and planishing; methods of treating waste paper; appliances, &c., for treating and moulding papier-mâché; manufacture of artificial parchment; recovery of waste products and preventing the pollution of streams.
- „ 138. MACHINES, &c., FOR CUTTING, FOLDING, AND ORNAMENTING PAPER.—Stamping; embossing; envelope and bag making; manufacture of playing cards; chromo-lithography; paper box machines; marbling; perforating; ruling; waterproofing; enamelling.
- „ 139. PAPER-HANGINGS.—Printing machines; apparatus for engraving printing rollers; materials; tests for injurious materials.

CLASS 140. LETTER-PRESS AND OTHER PRINTING.—Printing machines and presses; glazing and hot-pressing apparatus; apparatus, &c., for type-founding; lithographic machinery, materials, &c.; stereotyping apparatus, &c., methods of anastatic printing; process blocks from autographic drawings; wood blocks; engraving machines; machines for cutting wood letter; type-setting machines, numbering machines, printers' furniture and locking-up appliances; production of printing surfaces; methods of printing cheques, bank-notes, &c.

„ 141. **BOOKBINDING, MANUFACTURE OF PORTFOLIOS, &c., APPLICATIONS OF PAPIER MÂCHÉ.**—Materials; bookbinding machines, wire-stitching machines, cutting presses, rounding machines, backing machines, arming presses; account books, desks, cases, &c., for stationery, &c.; purses.

„ 142. **ARTISTS' IMPLEMENTS AND MATERIALS.**—Pencils, brushes, colours and varnishes, easels, crayons, palettes, palette knives, drawing boards, drawing instruments, pencil sharpeners.

„ 143. **WRITING MATERIALS AND APPLIANCES.**—Type-writers; manifold writers; copying presses and processes; processes for multiplying copies of MS.; pens; ink; penholders; inkstands; sealing-wax; stationery.

Group XXVII.—CLOCKS, WATCHES, AND OTHER TIME-KEEPERS.

(For electrical clocks, *see also* Group xiii.)

CLASS 144. CLOCKS.—Timepieces and other domestic clocks; regulators and astronomical clocks; watchman's, calendar, turret, electrical and pneumatic clocks; hour-glasses, sun-dials, water-clocks.

„ 145. **TIME SIGNALS, &c.**—Methods of controlling and synchronising clocks; apparatus for the distribution and signalling of time; also for the determination of time by astronomical observations.

„ 146. **WATCHES AND CHRONOMETERS.**—Examples illustrative of stages of manufacture and of the different types of watches and of chronometers; keyless, chronograph, repeating, calendar, and other forms of watches.

„ 147. **TOOLS, &c.**—Lathes and mandrils; wheel-cutting engines; machine tools for producing the several parts of watches on the “inter-changeable” system; various hand-tools used in the manufacture and repair of clocks and watches; gauges and templates; appliances used in case-making.

Group XXVIII.—PHILOSOPHICAL INSTRUMENTS AND APPARATUS.

(For testing machinery, *see* Group iii.; for commercial weighing apparatus, *see* Group xi.; for practical applications of electrical apparatus, *see* Group xiii.; for industrial applications of chemistry, *see* Group xiv.)

CLASS 148. OPTICAL.—Lenses, prisms, telescopes, microscopes and accessories, spectroscopes, polariscopes, polarimeters, stereoscopes, photographic lenses, spectacles, eye-glasses, optical glasses.

- CLASS 149. ASTRONOMICAL.—Telescopes (astronomical), transit instruments, equatorials, mural circles, driving clocks, siderostats, heliostats, altazimuths, methods of fitting observatories and mounting instruments.
- „ 150. PHYSICAL.—Acoustic apparatus, tuning forks, sirens, phonauto-graphs, phonographs; apparatus connected with molecular physics, air-pumps, manometers, radiometers; apparatus for measuring, &c., heat, thermometers, pyrometers, calorimeters; photometers; kinematic, static and dynamical apparatus; mechanics.
- „ 151. ELECTRICAL.—Friction and induction machines, batteries and other sources of electricity, Leyden jars, condensers, electroscopes, electrometers, galvanometers, voltmeters, dynamometers, magnetometers, rheostats, resistances, electrical units, induction coils, thermopiles, vacuum tubes.
- „ 152. CHEMICAL.—Thermometers, hydrometers, pyrometers, furnaces, blowpipe apparatus, assaying apparatus, apparatus for organic and inorganic analysis, for gas analysis, and for volumetric analysis, laboratory fittings and apparatus generally, balances, reagents.
- „ 153. MATHEMATICAL.—Calculating machines, indicating and registering apparatus, pedometers, counting machines, slide rules, planimeters, drawing instruments, ellipsographs, straight-edges, gauges, surface planes, dividing engines, pantographs, eidographs.
- * „ 154. METEOROLOGICAL.—Barometers, thermometers, rain gauges, manometers, hygrometers, aneroids, anemometers, ozonometers, storm signalling apparatus.
- „ 155. GEOGRAPHICAL.—Surveying apparatus, theodolites, chains, levels; underground surveying apparatus; apparatus for hydrographic surveying, and for marine investigations and observations; hypsometrical instruments, tide gauges; seismographical apparatus; projections, maps, charts, models, and globes.
- * „ 156. NAUTICAL.—Sextants, quadrants, sounding apparatus, logs, compasses.
- „ 157. WEIGHING AND MEASURING.—Weights, scales, balances; measures of length, graduated scales, verniers, steel tapes; measures of capacity; instruments for angular measurement, clinometers, goniometers.
- „ 158. BIOLOGICAL.—Apparatus for anatomical research; physiological apparatus; apparatus for collecting and preserving natural history specimens.

Group XXIX.—PHOTOGRAPHY.

(For applications of photography to printing, *see also* Group xxvi.; for photographic lenses, *see* Group xxviii.)

CLASS 159. PROCESSES AND THEIR RESULTS.—Methods of gelatino-bromide plate-making, apparatus for making emulsion, apparatus for separating the sensitive constituent, coating, drying and packing machines; emulsion and other processes; printing processes, silver, carbon, Woodbury-type, platinotype, gelatino-bromide, collodio-chloride of silver, &c.; apparatus for washing, &c.; prints and negatives; methods for making photographic lantern slides.

„ 160. APPARATUS (EXCLUDING LENSES).—Cameras, shutters, changing-boxes, slides, tents, lamps; apparatus for making enlargements and for micro-photography.

„ 161. APPLICATION OF PHOTOGRAPHY TO VARIOUS PURPOSES, TYPOGRAPHY, CERAMICS, RELIEF-MOULDS, &c.—Method of producing printing surfaces; photographic enamels, photographic printing on pottery; photographic reliefs. Use of photography in self-recording apparatus, in scientific observations, &c.

Group XXX.—EDUCATIONAL APPARATUS.

*CLASS 162. MODELS AND APPARATUS.—Appliances used in primary, scientific, technical, and artistic instruction.

Group XXXI.—TOYS, SPORTS, &c.

(For sporting guns, *see* Group xxv.)

CLASS 163. TOYS, GAMES, AND EXERCISES.—Outdoor games; gymnastic apparatus; skates, artificial skating surfaces; indoor games; billiard tables.

„ 164. FIELD SPORTS.—Apparatus used in hunting, fishing, shooting, &c.; traps for animals, birds, vermin, &c.

„ 165. SCENIC AND DRAMATIC EFFECTS.—Theatrical fittings and apparatus; optical (magic) lanterns and apparatus for illuminating them.

DIVISION II.—MUSIC.**Group XXXII.—INSTRUMENTS AND APPLIANCES CONSTRUCTED OR IN USE SINCE 1800.**

- CLASS 166. ORGANS.**—Details of construction ; machines for blowing, hydraulic or otherwise ; details of mechanism and the construction of pipes ; pneumatic apparatus for keyboards and couplers, electric appliances, designs for organs, designs for organ-cases.
- „ 167. **HARMONIUMS.**—American organs, vocalions, concertinas, accordions, varieties of reeds and air-channels, details of construction.
- „ 168. **WIND ORCHESTRAL INSTRUMENTS.**—(a) Wood ; (b) Brass.
- „ 169. **PIANOFORTES** (Grand, square, and upright).—Models of framings, castings, models of actions, pedal appliances, mechanical devices for tuning and transposing, wire and other material used in construction, designs for cases.
- „ 170. **VIOLINS, AND INSTRUMENTS OF THE VIOLIN FAMILY ;** Bows, strings, and inventions connected with these instruments.
- „ 171. **HARPS.**
- „ 172. **AUTOMATIC AND BARREL INSTRUMENTS.**
- „ 173. **DRUMS, CYMBALS, AND OTHER INSTRUMENTS OF PERCUSSION.**
- „ 174. **BELLS AND CARILLONS.**
- „ 175. **NATIONAL INSTRUMENTS OF ALL COUNTRIES NOT ORDINARILY USED IN ORCHESTRAS.**
- „ 176. **SIRENS, TUNING FORKS, PITCH PIPES, TONOMETERS, and appliances for the determination of pitch.**
- „ 177. **MISCELLANEOUS MUSICAL APPLIANCES.**—Metronomes, desks, seats, appliances for forming the hand ; instruments for recording improvisation.

Group XXXIII.—MUSIC ENGRAVING AND PRINTING, MODERN PAINTINGS, &c.

- CLASS 178. PRINTED AND ENGRAVED MUSIC : AND MACHINES AND APPLIANCES FOR ITS PRODUCTION.**
- „ 178a. **MODERN PAINTINGS, DRAWINGS, AND ENGRAVINGS OF MUSICAL SUBJECTS.**

Group XXXIV.—HISTORIC COLLECTIONS.

- CLASS 179. MUSICAL INSTRUMENTS AND APPLIANCES.**
- „ 180. **PICTURES, ENGRAVINGS, AND DRAWINGS OF MUSICAL SUBJECTS.**

LOAN COLLECTION OF HISTORIC MUSICAL INSTRUMENTS AND APPLIANCES, MANUSCRIPTS AND PRINTED BOOKS, PICTURES, ENGRAVINGS, AND DRAWINGS OF MUSICAL SUBJECTS.

- SECTION I.—Stringed Instruments with Keyboard.
 " II.—Stringed Instruments with a Bow.
 " III.—Harps, Lutes, Guitars, Zithers, Dulcimers, &c.
 " IV.—Trumpets, Horns, and similar Wind Instruments.
 " V.—Flutes, Oboes, and similar Wind Instruments.
 " VI.—Organs and other instruments containing Organ Pipes or Tongues of Metal.
 " VII.—Percussion Instruments; Drums, Stones, Cymbals, &c.
 " VIII.—Mechanical; by Handle or Automatic Mechanism.
 " IX.—Miscellaneous; Castanets, Conductors' Bâtons, Metronomes, Tuning Forks, Æolian Harps, Glasses, &c.
 " X.—Ethnological.
 " XI.—Manuscripts (Old Scores, &c.), Choir Books, Lecterns, Choir Stalls, and other Ecclesiastical Objects relating to Choirs, Printed Books, &c.
 " XII.—Paintings, Engravings, Drawings, &c.

The Loan Collection will be open from the beginning of May to the end of October, 1885. The Group devoted to this object will resemble in its main features the Loan Collection of Historic Musical Instruments which was held at South Kensington in the year 1872. The scope, however, is more extended, the intention being to illustrate the history of music as fully as possible.

In order that every precaution may be taken regarding the safety and proper keeping of the valuable objects exhibited on loan, it has been decided to set apart for that purpose the fireproof galleries of the Royal Albert Hall. The cases in which they will be displayed will be of an equally secure description to those in use at the South Kensington Museum.

The arrangements regarding the carriage of the objects lent for Exhibition will be of a similar character to those made at the 1872 Exhibition. Official vans will be used, the packing will be under the direction of experienced persons, and all charges of transit will be defrayed by the Executive Council.

Any further information on the subject will be given on application to the Secretary.

RULES RESPECTING THE RECEPTION OF OBJECTS LENT FOR EXHIBITION.

1. All Loans are received on the understanding that they are at the absolute disposal of the Executive Council during the time the Exhibition is open, and are to be exhibited in the Gallery set apart for the purpose in such a manner as the Council think fit.
2. Whilst every care is taken of objects lent for exhibition, the Executive Council (following the rule of the Royal Academy, the South Kensington Museum and other bodies) cannot be held responsible for loss or damage.
3. Permission to copy or photograph objects on loan is not granted to private persons without the sanction, in writing, of the lender.
4. All charges of transit will be defrayed by the Executive Council.
5. The reception of Loans will begin on the 1st of April, and the necessary official labels for packages will be supplied to owners as they may request.

Society of Arts Prizes.

The Council of the Society of Arts announce that they are prepared to award the following Gold Medals in connection with the International Inventions Exhibition :—

Under the JOHN STOCK Trust, one Gold Medal, for the best application of Photography to a Permanent Printing Process. Group XXVI., Class 140; Group XXIX., Class 159.

Under the HOWARD Trust, five Gold Medals, for the best exhibits (coming within the terms of the Trust*) in the following Classes :—

One for the best exhibit in Group IV., "Prime Movers," Class 26. Steam Engines and Boilers.

One for the best exhibit in Group IV., Class 27. Gas and Air Engines.

One for the best exhibit in Group IV., Class 28. Means of Utilising Natural Forces.

One for the best exhibit in Group XI., "Hydraulic Machines, &c.," Classes 59 to 62.

One for the best exhibit in Group XIII., "Electricity," Class 72. Distribution and Utilisation of Power.

Under the FOTHERGILL Trust, one Gold Medal for the most novel and best exhibit in Group XXVIII., "Philosophical Instruments and Apparatus," Classes 148 to 158.

Under the ALFRED DAVIS Trust, three Gold Medals, to be awarded in Division II. of the Exhibition (Music), Groups XXXII. to XXXIV., Classes 166 to 180.

The Council of the Society propose to ask the Juries in each Class to recommend for their consideration either two or three exhibits which they might consider deserving a prize. It will not be necessary for any special application to be made in respect of these Prizes.

* The Trust was left "for the purpose of presenting periodically a prize or medal to the author of a treatise on the properties of Steam generally, or any of them particularly, as applied to motive-power, or it may be of air or permanent gases, or vapours, or other agents so applied, or to the Inventor of some new and valuable process relating thereto."

Choral Competitions.

GENERAL REGULATIONS.

1. All applications for admission to the competitions must be made to the Secretary (on printed forms provided for the purpose by him) not later than 1st April, 1885.
2. A certificate will be required under the signature of the Conductor and Secretary of each Choir entering for competition, declaring that the Choir has been actually constituted for not less than six months prior to the date of application.
3. Choirs must enter (1) as consisting entirely of amateurs, or (2) as consisting of amateurs assisted by professionals; but under the latter head no Choir will be eligible to compete which has a larger proportion of professionals than one professional member to every fifteen amateurs; and the names and addresses of all professional members must accompany the application. No professional will be allowed to take part in any competition who has not been a member of a Choir to which he belongs for at least six months prior to the date of filing applications (April 1st, 1885). [By a "professional" is meant any person who is receiving, or has received, pay for musical services rendered, either to the particular Choir or to any other persons or body.]
4. Each Choir will be required to sing two unaccompanied pieces selected by the Council, the names of which will be given on entering the Choir for competition, and also one unaccompanied piece of its own selection. The Choirs of Female Voices will, however, be allowed a pianoforte accompaniment to two of the three pieces selected.
5. By "member of a Choir" is meant a performing member.
6. If only a portion of a Choir, or a selection of members, enters for competition this must be stated, and full particulars given as to the number of non-competing members, and why they are absent.
7. No competition will take place in Classes I. or II. unless three Choirs at least enter in either class; and no competition will take place in Classes III. and IV. unless two Choirs at least enter under either class; and no competition in Class V. or VI. unless two Choirs shall enter under either class; but it shall be in the power of the musical umpires to recommend a gift of money to any deserving Choir excluded from competition from this cause only.
8. Secretaries of Choirs are requested to communicate with the Official Agent of the Exhibition, 96 London Wall, E.C., relative to the arrangements which the Executive Council have made with the Railway Companies, whereby special facilities may be secured by the Choirs, for travelling on favourable terms. Actual competitors will receive free admission to the Exhibition.

In addition to such sums as may be given from local sources, the Executive Council have determined to award the following prizes.

PRIZES.

CLASS I.—Choirs of mixed voices (Trebles, Altos, Tenors, Basses) numbering not less than 100 members.

First Prize	...	...	...	...	...	£100
Second „	...	...	...	...	...	60
Third „	...	...	...	...	...	30

CLASS II.—Choirs of mixed voices (Trebles, Altos, Tenors, Basses) numbering not less than 50 or more than 100 members.

First Prize	...	...	...	...	...	£60
Second „	...	...	...	...	...	35
Third „	...	...	...	...	...	15

CLASS III.—Choirs of Female voices only, numbering not less than 50 or more than 100 members.

First Prize	...	...	...	...	...	£60
Second „	...	...	...	...	...	40

CLASS IV.—Choirs of Female voices only, numbering not less than 30 or more than 50 members.

First Prize	...	...	...	...	...	£30
Second „	...	...	...	...	...	20

CLASS V.—Choirs of Men's voices, numbering not less than 60.

First Prize	...	...	...	...	...	£60
Second „	...	...	...	...	...	40

CLASS VI.—Choirs of Men's voices, numbering not less than 30 or more than 100 members.

First Prize	£30
Second „	20

Total amount of Prizes, £600.

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INTRODUCTION.

At the closing ceremony of the Fisheries Exhibition, His Royal Highness the PRINCE OF WALES laid down a programme for the three following Exhibitions:—The first of these was the International Health Exhibition, held last year; the second, an Exhibition of Industrial Inventions, especially Labour-saving Machinery; and the third, an Indian and Colonial Exhibition.

With regard to the Exhibition of Inventions, His Royal Highness said:—“The question of the Patent Laws has for many years engaged the attention of all those interested in the progress of invention and the just reward of the inventor. I am advised that the Patent Act of last Session will afford a satisfactory solution of the difficulties which beset this subject, and will be especially useful to the poor inventor, by enabling him to obtain protection for his invention at a considerably reduced rate, and in a manner which will be more advantageous to him. Under these circumstances, it has appeared to me that much good may result from an Exhibition in the year 1885, showing the progress of invention, especially to labour-saving machinery, since 1862—that is to say, since the last great International Exhibition held in this country.”

So far as can be judged from the experience of a little over a year, the results anticipated by His Royal Highness from the working of the Patent Act which came into operation in January, 1884, offer full promise of realisation. The number of patents applied for last year reached a total of 17,110, the largest number reached in any previous year having been 6241 in 1882. The value of the inventions, which are the subject of those patents, cannot as yet be judged; but there seems no reason to suppose that they are much below the average of previous years, and therefore it may fairly be concluded that the lower scale of fees introduced by the Act has enabled a large number of inventions, which would otherwise have been left unprotected, and therefore practically useless to their inventors, to secure the benefit of protection.

The statistics above referred to show how large a range was open to an Exhibition of Inventions, and how well suited is the present time for such an Exhibition. The advance which has been made during the past twenty years, in the application of science to practical purposes, is briefly but sufficiently indicated in the Introductions to the several Divisions of this Catalogue. A reference to them will show that while in every department of industrial science, as represented by the groups of the Exhibition, progress has been steady and extended, in some such as Electricity and Chemistry, it has been startling.

To the subject of Inventions was afterwards added that of Music; and as much as Music had not been specially dealt with in any previous Exhibition, and also because there was not the same difficulty in bringing this part of the Exhibition within the limits of the space available for it, the restrictions of time enforced in the Inventions Division were not needed, and so it was decided

to admit instruments of any date not earlier than the beginning of the present century. In addition, it was determined to add a Loan Collection of Musical Instruments, Appliances, Pictures, &c., of any date.

The first steps for the organisation of the Inventions Exhibition were taken at a much earlier date than was possible in the case of the Health Exhibition, which was only determined upon at the conclusion of its predecessor in the month of October, 1883. The Council of the Inventions Exhibition was appointed by His Royal Highness the President in the spring of last year, and they held their first meeting on the 7th of June. The general nature of the Exhibition had been indicated by the PRINCE OF WALES, but its precise scope and extent required to be determined with considerable care. The field of invention is a very wide one, and one not very easy to define. Eventually, however, it was decided to accept practically the limitations of the Patent Law, and to consider any invention which might fairly be subject-matter of a patent, as coming within the range of the Exhibition. The practical exigencies of space, however, required that some further limitation even than the limitation of time above mentioned, should be put upon Exhibitors, and as it was obviously undesirable that there should be again presented to the public what had already been sufficiently exhibited in recent years, it was decided to limit very strictly the space which might be allotted to inventions of the nature of those shewn in the Smoke Abatement Exhibition 1881, in the Fisheries Exhibition 1883, or in the Health Exhibition 1884. Further than this, it was felt that the annual Exhibitions of the Royal Agricultural Society of England gave persons interested such full opportunities of studying the progress of agricultural machinery that here again arbitrary restrictions might be imposed. It was not thought well to leave these classes of invention entirely out of the classification, as this would not only render the Exhibition as a whole incomplete, but would prevent an opportunity being given for anything of very great novelty belonging to one of the above classes finding a place. The classification was therefore made as complete as possible throughout, those Classes in which space was to be limited being specially indicated. The classification was based to a large extent on that adopted by the Patent Office, a classification which is the result of more than thirty years' experience of such work; but it had to a very large extent to be modified to render it suitable for Exhibition purposes.

The classification of Division II., MUSIC, was partly founded on that adopted by the Juries of the 1851 Exhibition; but it was considerably elaborated, and there was added to this a Group for Music Engraving and Printing, and another for the Loan Collection previously mentioned.

The date for the reception of applications for space was fixed for the 1st of November, 1884; and by that time a very large number were in the hands of the Council. These applications, as soon as they had been arranged under their respective Groups, were all of them submitted to Committees selected from amongst the members of Council or the members of the Committee of Advice. By these Committees a very large number of applications which did not appear in their judgment to be of sufficient interest, were rejected, and even after a selection of the most promising inventions had been made, it was found

necessary to reduce the number still further, in consequence of there not being sufficient space to accommodate all those which had been selected.

In order that the greatest possible number of applicants might be admitted, considerable additions were made to the buildings, but even when all the available ground was occupied, the galleries were really insufficient to meet the demands upon them.

From an inspection of the entries in the following pages it will be seen that the manufacturers and inventors of the country have readily come forward to assist in carrying out the suggestions made by H.R.H. the President of the Exhibition, and there is every reason to believe that the anticipations expressed by His Royal Highness in making those suggestions will be fully realised.

THE plaster cast in the Entrance Hall is that of the Statue in Bombay of Albert Edward, Prince of Wales, K.G., G.C.S.I., in commemoration of the visit of his Royal Highness to India, 1875-76. Sir Albert Sassoon, C.S.I., Kt., presented this statue to his fellow townsmen of the Royal City of Bombay.

THE decoration of the Entrance Hall has been entrusted to Messrs. Gillow, and the Executive Council appointed a Committee who directed that the mural spaces should be treated decoratively with cartoons illustrating the historical development of some of the principal Inventions represented in the Exhibition.

An ancient and a modern subject has accordingly been prepared for each of the selected Groups—the early examples being in nearly all cases taken from original drawings of the 16th century.

NOTE.—*The Numbers above the Panels are those of the Classes in the Exhibition which the Cartoons illustrate :—*

CLASS	CLASS
8. Ore Dressing; from Agricola's work 'De re Metallica' (1555).	48. Early Loom; from Jost Amman's 'Stände und Handwerker,' Frankfort-on-the-Maine (1568).
8. Hydraulic Mining, California; the 'Century' Magazine (1883).	48. Modern Loom.
9. The Catalan Process of Iron Smelting, introduced in the 13th century.	66. The First Electrical Machine, Otto v. Guericke (1663), from his 'Experimenta Nova,' published 1673.
9. The Bessemer Process for converting Cast Iron into Malleable Iron or Steel.	66. The Gramme Dynamo Machine.
15. Ancient Bridges; from Original Drawings by Leonardo, da Vinci (about 1520).	129. Boring and Preparing Mould for Casting Cannon; from Biringuccio's work, 'De la Pirotechnia' (1540).
15. The East River Bridge, New York; 'The Graphic.'	129. Modern Woolwich Breach-Loading Cannon.
26. Early Locomotive; George Stephenson's "Rocket" (1829).	140. Early Printing Press (1520). [non.]
26. Modern Locomotive.	140. The 'Walter' Press, in use at the 'Times' Office.
41. Miller & Symington's Steamboat (1788).	144. Ancient Clock Maker, Jost Amman's 'Stände und Handwerker' (1568).
41. Atlantic Steamer.	146. Modern Watch Factory.

COMPLIMENTARY LIST.

THE EXECUTIVE COMMITTEE is indebted to the following gentlemen for Special Services rendered; and for the Exhibits specified below, which have been courteously lent for the use of the Executive at the installation of the Exhibition, and throughout its term.

ALDOUS & SON, Ventilating Sanitary & Consulting Engineers, 2 Elmhurst, Upton Lane, Forest Gate, E.; and 14a George Street, Camberwell, S.E.; by their Trunk System have ventilated the Vice-Chairman's Room and Staff's offices; also ladies' retiring rooms and lavatories. The Trunk System of Ventilation was never applied until this firm invented an exhaust which is free from down draught, and capable of extracting any amount of vitiated air that can be conveyed to it. The Trunk System is carried out by means of one exhaust being placed at any sufficient elevated position on the house or building, and air tubes carried from each room or compartment into the body of the exhaust, so every room is cleared of vitiated air simultaneously and independently of each other.

ASBESTOS CO., Limited (THE UNITED), 161 Queen Victoria Street, E.C.; and Clement Street Works, Birmingham.—This Company's Asbestos Patent Fire-proof Paint has been used by the Executive Council for the wooden buildings of the Exhibition, and the gable ends have been painted and decorated by the Company free of charge. This Paint is made from the finest quality of Asbestos, obtained from the Company's extensive mines in Italy, and has been clearly proved to be a valuable protection against fire.

ATTWOOD & CO., Ulverston, have lent Revolving Shutters for front of boilers in North Court.

BANNER BROS. & CO., Consulting Sanitary & Ventilating Engineers, 11 Billiter Square, E.C., have applied their system of Ventilation to the International Inventions Exhibition, consisting of Inlet Tubes and Exhaust Fixed Ventilators for extracting the vitiated air from the rooms. These Ventilators, and Banner's System of Sanitation and Drainage, have been applied to the whole of the drains of the International Inventions Exhibition, 1885.

BARSANT, HENRY, & SONS, West London Parquet Works, 18 Wells Mews, Wells Street, Oxford Street, W., have supplied the Parquet Flooring in the Council Room.

BENHAM & SONS, Wigmore Street, London, W., have supplied and erected in the Council Room (1) A Carved Walnut wood Chimney Piece, with Over Mantels and Silvered Glass Panels. (2) An Encaustic Tile Hearth. (3) A Marble Fender. (4) An Edwards' Smoke Consuming Slow Combustion Grate. Also in the Secretary's office (5) A Marble Chimney Piece. (6) Fender. (7) Encaustic Tile Hearth. (8) Edwards' Smoke Consuming Slow Combustion Grate. Also in three other offices (9) Two Improved Office Stoves on Tile Hearths. (10) An Improved Lavatory Table.

BOYD, D. O., 19 Maddox Street, W—Boyd's Stove, fixed in the Surveyor's office is simply an adaptation of the Hygiastic Ventilating Grate. The stove illustrates the Hygiastic principle only, without any attempt at ornament.

BRITISH PATENT GLAZING CO., Limited, (THE), 24 Finsbury Circus, E.C., have erected the glaze in front of the Council Room, using their patent system, which consists of solid rolled malleable iron bars (which can be made any length) enveloped with light sheet lead. The glass rests upon a soft metal bed, and is secured by folding the lead over the glass. The shape of the bar provides channels for carrying off moisture, and provision is made for expansion and contraction. Special shoes are made for fixing on to the ridge and sill, into which the top and bottom ends of the bars are fitted.

BROWN & GREEN, 69 Finsbury Pavement, London, E.C.—Brown & Green's Ventilating Stove has been fixed in one of the offices of the Executive in the Exhibition. This stove can be regulated to burn as a slow or quick combustion stove. It is lined with fire brick, it has a loose cover, which is easily removed for the supply of fresh fuel without the least escape of smoke; near the top of the stove is a ventilator for the admission of a current of air over the fire direct to the flue, which ignites and prevents the accumulation of gases, and assists in ventilating the room.

CADOGAN IRON WORKS, Stanley Bridge, King's Road, Chelsea, S.W.—A Circular Iron Staircase to Clock Tower.

BELL, SMITH, & CO., 75
Street, Oxford Street, London,
 and Painted Glass, exhibited in
 al Gallery Annexe, consisting of
 els, viz: "Procession of the Pea-
 arrangement of Magnolia," "Sculp-
 August, month of," "March, month
 the Great examining a Model in
 Dockyard," "Morning," "Head of
 Raleigh," "Fable Fortune & Boy
 "Foliage," "Italian Ornament,"

BUNNETT, & CO., Limited,
Place, London, W.—Dinner
 staff rooms. It serves from kitchen
 and the gear being fitted with
 rollers a quick and noiseless
 motion. The iron staircase to the
 has been erected by the same com-

WILLIAM, & SONS,
ake Street, Stamford Street,
 Press, Compositors' Room, and
 staff of printers to undertake, in
 Buildings, printing for the
 Council.

LY, H., 53 & 55 Hampstead
don, N.W., has placed windows
 all Room and Staff Room, and gas
 Council Secretary's and Chairman's

PAXMAN, & CO., En-
olchester.—This firm supplied
 and boiler power necessary for work-
 of the vast system of electric
 throughout the late Health and
 Exhibitions. At the Fisheries Exhi-
 1000 horse-power was employed,
 Exhibition about 1300 horse-
 at the present Exhibition 2300
 in steam is provided for. The
 of neat design, and excellent
 Great facility is given for
 all parts, and the special require-
 Electric lighting have been well
 The power is greater than that
 any which has yet taken place.
 engines provided for this purpose
 number. The two largest engines
 of developing 750 horse-power.
 engines are of the coupled horizon-
 as fixed by D. P. & Co. for
 electric light at the South Kensington,
 and provided with Paxman's
 Cut-off Gear, worked direct
 so as to ensure very steady
 running. The advantage of this
 only just sufficient steam required
 is admitted to the cylinder at each
 piston. This is one of the very
 arrangements which work with
 and certainty. The cylinders are
 It may be mentioned that

one of the large driving bands on one of the
 engines suddenly broke when the engine was
 transmitting about 350 horse-power, but the
 excellence of the automatic gear—even in this
 extreme case—prevented the engine from over-
 running. No. 3 engine is of the compound
 receiver type, indicating 200 horse-power. It
 is fitted with Paxman's Automatic Gear as
 above described. The cranks are at right
 angles, and accurately balanced. With con-
 densers and good generators, this engine will
 work with less than 2 lbs. of coal per indicated
 horse-power per hour, and run very smoothly
 and with great steadiness. No. 4 engine is
 of D. P. & Co.'s semi-fixed compound type, of
 140 indicated horse-power, and is precisely the
 same as No. 3 above described, but with
 locomotive boiler placed above the engine. At
 the Health Exhibition this engine, although
 without condenser, ran constantly with 2½ lbs.
 of fuel per indicated horse-power per hour.
 No. 5 engine is a double cylinder semi-fixed
 Steam Boiler. A battery of eight large
 boilers, of the locomotive type, is fixed
 between the two large coupled engines for
 supplying them, as also some high speed
 engines, with steam. There is also a second
 battery of six boilers on the west side. The
 whole of these are made to work at 100 lbs.
 steam pressure. The fireboxes are of D. P. &
 Co.'s improved mild steel, which has given such
 good results. Altogether nearly 2300 horse-
 power in boilers are provided for. Receivers
 16 in. diameter have been placed along the top
 of the two batteries of boilers. In addition to
 the above machinery in the electric lighting
 shed, Messrs. D. P. & Co. exhibit a Compound
 Quick Speed Engine, single acting, for driving
 dynamos direct from the crank shaft. Also
 Compound Vertical Engine, double acting, for
 driving dynamo with gear and two vertical
 boilers.

DAVIS, H. C., & CO., 200 Camber-
well Road, London, S.E., have supplied in
 the kitchen of the staff rooms their Metropolitan
 Ventilated Gas Kitchener for roasting joints,
 &c. The hot plate consists of three or more
 boiling or stewing burners, each under separate
 control. A special feature is the Patent Steel
 Heat Deflector, which, when placed over the
 grilling burner, very rapidly becomes red hot
 and so deflects the heat, that grilling meat or
 fish or toasting bread is performed as rapidly as
 if done with a clear coal fire; although being
 utilized for toasting underneath the burner, can
 be utilized at same time for boiling, &c.

DOULTON & CO., Lambeth, Lon-
don.—Two Open Faience Radiating and Ven-
 tilating Tile Stoves, to ensure a constant current
 of warm fresh air, including glazed fenders
 and hearths. Combining cleanliness, utility,
 and economy of fuel with the cheerful appear-
 ance of an open fire, which is so much desired in
 our country. These stoves have been placed in
 the rooms set apart for the accommodation of
 the London and Provincial Press.

EDMUNDS, JOSEPH, 10 Stonefield Terrace, Liverpool Road, London, N.—Hexter's Currie Powder and Paste.—Edmunds' Empress Currie Powder, Paste, and Sauce, for use in the Practical Cookery Lectures.

GAINSFORD & CO., 163 to 167 Borough, London, S.E., have placed at the disposal of the Executive, the furniture and accessories of the Council and Chairman's rooms, Jurors' and Superintendent's offices.

GALLOWAY, W. & J., & SONS, Knott Mill Iron Works, Manchester, have supplied seven of their well-known 1875 Patent Galloway Boilers, which provide steam to the general bulk of the exhibitors in the various departments, those in the Western Gallery being 26 ft. by 6 ft. 6 ins., and those in the North Court 28 ft. by 7 ins. The whole of these boilers are constructed entirely of steel plates, and are suitable for an ordinary working pressure 80 lbs. to the square inch. Messrs. Galloway have also supplied one of their well-known Twin Horizontal Compound Engines, capable of giving off 125 horse-power, having cylinders 14 in. and 24 in. diameter, 2 in. 6 in. stroke for driving the machinery in the Western Annexe, as well as one of their new Horizontal Compound Superposed Engines in the North Court, with cylinders 14 in. and 24 in. diameter, 3 ft. stroke, suitable for giving off 160 horse-power. Messrs. Galloway have further supplied the whole of the shafting and framework for carrying the same in both the Western Gallery and new North Court, and also the whole of the steam and exhaust piping throughout the whole building.

GILLOW & CO., Decorators to the Queen, 406 Oxford Street, London; Liverpool, Lancaster and Manchester.—The Royal Pavilion. The complete structural decoration and furniture, comprising the Entrance Hall and Alcoves, adjoining, in the Egyptian style with panels of Musharabyeh Woodwork, Oriental Embroideries, Carpets, Metalwork, and Faience. The Drawing-room of white woodwork, with decorative furniture in the style of Louis XIV. The Panels and Pilasters, painted on gold in shades of grey and blue. The Chairs and Tapestry Panels of Royal Windsor Tapestry. The Dining Temple in the Classic style, with niches and divans in colour, the room adjoining being hung with Italian Mezzari. The floors of the various rooms are laid with Parquet and Anglo-Persian Carpets, specially manufactured. The whole illuminated with Electric Light. The Candelabra, blocks and other objects in gold and bronze, manufactured and lent by Messrs. Elkington & Co., Regent Street. The Venetian Glass, Electroliers, Girandoles and ornaments, manufactured and lent by Messrs. Salviati, 213 Regent Street. The Conservatory has been built and furnished by Messrs. Dick Radclyffe & Co., 128 and 129 High Holborn. Messrs. Gillow have also pro-

vided the decorations, fittings, and furniture the rooms provided for the accommodation of the London and Provincial Press.

N.B. As the Royal Pavilion must be ready at the close of the Exhibition, permission has been obtained to dispose of the building the whole of the contents.

GREAT WESTERN RAILWAY CO. (THE), have kindly lent 2,000 feet of rails for getting in many of the larger exhibits such as locomotives, artillery, &c.

HANSON, SCOTT, & CO., Stockport, have lent the ropes necessary for driving Fowler's engine.

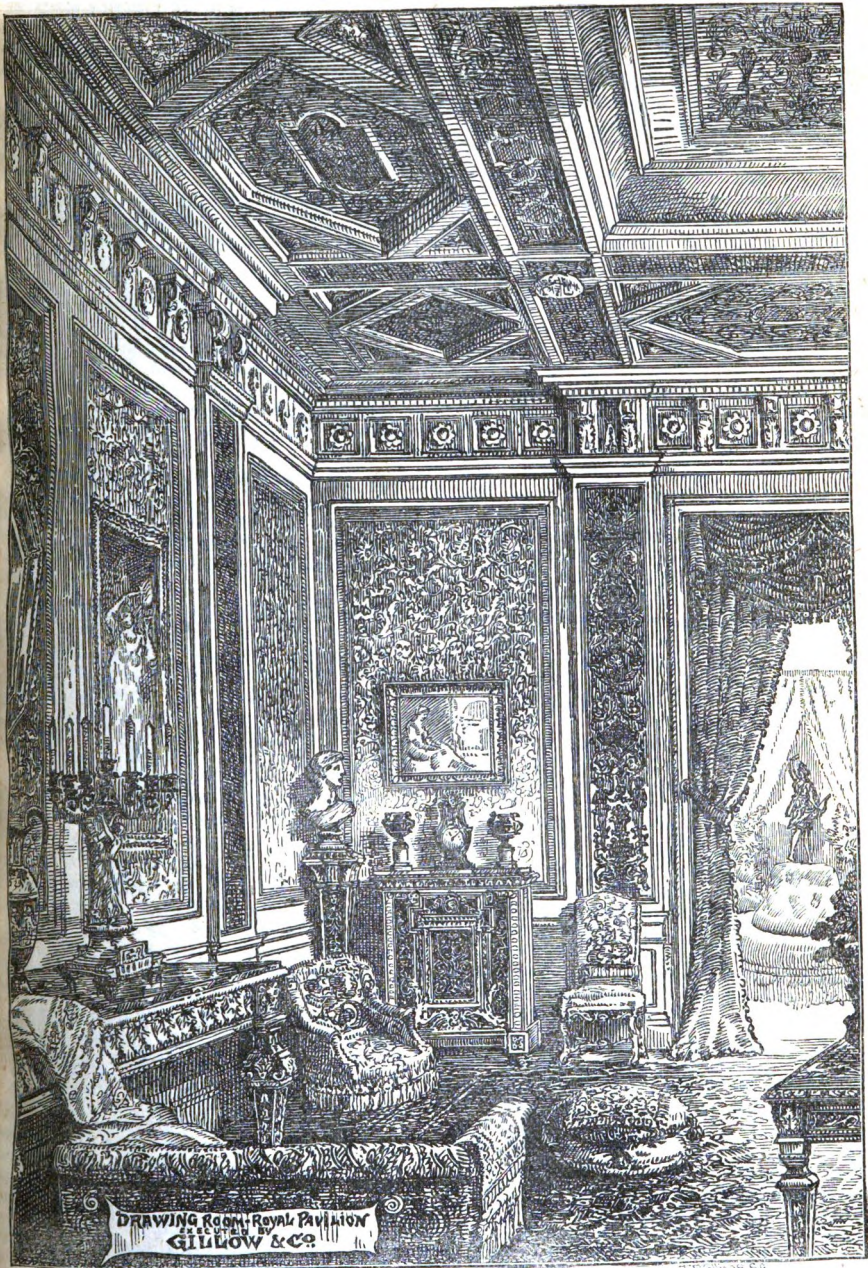
HARDEN STAR HAND GRENADE FIRE EXTINGUISHING CO., Limited (THE), 1 Holborn Viaduct, London, E.C.—Loan of 1,000 Hand Grenades for the protection of the Exhibition Buildings in case of fire.

HARDING, CHARLES D., Chesham, Bucks.—Special Services in providing for Decorations of the Exhibition Buildings.

HELLIWELL & CO., 8 Abchurch Lane, London, E.C.—A Patent System of Imperishable Glass without putty. The glass is carried on iron bars, made either of zinc, copper or galvanized iron. These bars have double channels, the upper one of which the glass rests, and in its place by metal caps, screwed down the outside with brass bolts and nuts. The glass is easily repaired, broken squares being replaced by simply unscrewing the nuts. A drainage system is provided for at the laps and by a special bar, the condensation being carried to the outside.

HICK, HARGREAVES, & CO., Soho Iron Works, Bolton, Lancs.—(1) Corliss Valve Steam Engine, with greaves and Inglis' New Patent Automatic Valve Gear. (2) Steam Jacketted Compound Engine, built up with separate end valve chest, Patent Motion for stopping engine. (3) Knowles' Patent Automatic Supplemental Governor for maintaining almost perfect accuracy of speed under varying loads or pressures, very important for spinning. (4) New Patent Automatic or Safety Engine for turning the main engine. (5) Pulley Fly Wheel, built up on improved design. (6) Patent Metallic Packing for pistons.

IMPERIAL STONE COMPANY, Limited, 41 & 42 Parliament Street, London, S.W.—Imperial Stone is used for the manufacture of steps, lamp pavings, copings of various designs and really for stonework dressings connected with buildings. This stone is composed of granite and Portland cement, the free dust being very carefully eliminated by sieving before being mixed with the cement material is then placed in moulds and



DRAWING ROOM, ROYAL PAVILION
GLULOW & CO

pressed by machinery. It has been found that stone made artificially in this manner stands the severe test of a London atmosphere successfully. It is in some instances mixed with various pigments in order to obtain the colour contrasts desired by the architect, great care being exercised to use only such as will not injure the cement. The stone is in all cases after being sufficiently dried subjected to a bath of silicate of soda and other indurating processes.

JONES, T., 36 Sloane Street, London, S.W.—Jones's Ventilators. The object of this invention is to construct ventilators in so simple a manner that they cannot get out of order. (1) Is intended to admit fresh air through a grating placed in the outer wall so that no draft can be felt, it can be regulated to suit all changes of temperature. (2) Is placed in chimney breast, and becomes in an ordinary good smoke flue an air syphon, which draws off burnt gas, tobacco smoke, smell of cooking, &c., it is very serviceable where kitcheners and modern stoves are used.

KEENAN, M., of Armagh Works, Row, have placed at the disposal of the Executive large supplies of his Improved Boiler Preparation, the whole of the pipes and boilers in the engineering section being coated with the same.

KIMBERLEY, ALBERT, Contractor, &c., Banbury, has supplied the wood block flooring in the basement of staff rooms and in the ladies lavatory adjoining the dining rooms. The blocks are made to a uniform thickness of $1\frac{1}{2}$ inches, and can be arranged to any pattern. They are prepared by a special process to resist dry rot. Being laid on a solid bed of concrete 6 in. thick they are noiseless, and are especially suitable for the floors of basements, churches and schools on this account, and also because of their imperviousness and economy in cost and laying.

LASCELLES, W. H., & CO., 121 Bunhill Row, London, have executed in American walnut the Entrance Doors, Room Doors, Architraves and Overhead Pilasters with carved caps, moulded skirting and Sarabae moulding in the Council Room.

LINCROSTA AND GENERAL DECORATING CO. (THE), 184 Oxford Street, London, W.—Decoration of the Vice-Chairman's Room. The whole of this room is decorated in Lincrosta-Walton, a damp-proof, washable material with designs in solid relief. Above the dado, which is treated in a rich deep red with brown glaze, the walls are panelled and the material in the panels decorated in lacquers. A shell pattern is used on the ceiling treated in one tint, and the adaptability of the Lincrosta for the enrichment of wood work is exemplified in the mouldings of the door and windows, and in the cove cornice. The windows are fitted with some choice specimens of painted glass repre-

sented Tristram and Elaine, Iseult and Lancelot, Vivian and Merlin. The above Company have also supplied the Lincrosta decorations in the Press Room Offices in last year's Exhibition, and in the present one.

LUCAS & AIRD, 5 Great George Street, Westminster, London, S.W., have supplied two large Trolleys for bringing in exhibits.

MOORE, A. L., & CO., 89 Southampton Row, London, W.C.—Stained and Painted Glass exhibited in the East Annexe, consisting of a variety of windows and lights designed for both ecclesiastical and domestic purposes. On one side of the Corridor in which their work is situated is a window treated with conventional foliage on a light grey background and having a border of shamrock pattern, suitable for a staircase of a public or private building, four heraldic panels on diapered quarry ground-work, containing the arms of England, Scotland, Ireland, and Wales, between them being a subject panel, representing a scene from Sir Walter Scott's 'Lady of the Lake,' worked on antique white glass without much positive colour. To the right hand of the above is a figure panel emblematical of Sculpture, this being a replica of a portion of the Library Screen at the Grand Hotel, S.W. Beneath this is a window in six divisions with an allegorical subject illustrating Fame distributing laurels, surmounted by the Prince of Wales' feathers and motto. On the opposite side of the Corridor are portions of two lights of a church window, the subject treated being the Parable of the Pharisee and Publican, surrounded by light gresaille ornament with a richly coloured border. There are also three panels of geometrical glazing in tinted antique glass, and on each side of them, one of foliage glazing in coloured antique glass, the other of a lightly traced and coloured ornamental character. To the right hand of these is an heraldic panel, and one showing delicate foliage, with a central medallion containing a fancy head, beneath them being two highly finished panels with a figure in each representing Hunting and Hawking, suitable for door panels. Besides the above, this firm also exhibits some painted glass in the Secretary's and Press Rooms.

MOORE, JOSIAH, & SONS, Sekforde Works, St. James's Walk, Clerkenwell, E.C.—In the windows of the Eastern Arcade, on right hand of Chief Entrance, near New Dining Rooms, in roofs of Gentlemen's and Ladies' Lavatories in Gardens, and in the new Council Chamber, this firm have supplied and fixed some of their Patent Improved Glass Louvre Ventilators, by which the admission of air is directed upwards and diffused, thus causing a continuous circulation of air and at the same time excluding rain. They can be regulated at pleasure to any degree by means of a very simple and efficacious arrangement worked by a single cord, and are self-closing:

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and being made chiefly of glass, no obstruction of light takes place.

NORTON DOOR CHECK AND SPRINGS, 46 Holborn Viaduct, London, E.C.—The principle upon which these springs are made renders it (when they are attached in accordance with directions) utterly impossible for the door to remain open or to shut with a slam. The device consists of a Cylinder, Piston, Spring and self-adjusting Valve. It is provided with suitable brackets, and is adapted to be attached to the top part of a door and the frame over the door. In it are two great powers, namely the spring, which is sure to close the door, drawing the hardest when it is the nearest closed, and the check, or the cushioning of the piston on air, which brings the door to a stop for an instant near the jamb, then quietly but surely closing the door and latching it by the operation of the spring, being regulated by the Automatic Valve, which permits the air to enter the Cylinder freely while opening the door, and while closing exhausts the air, more or less, as the force exerted on the door to close it is greater or less.

PATENT VICTORIA STONE CO., 283 Kingsland Road.—The Patent Victoria Stone is laid under the Portico, in the Entrance Hall (Fish Market, Great Refreshment Bar now), Dining Kitchen, and in front of the American Bar. The steps in the terraces are also of the same material. It is an artificial stone, which has been largely used during the last thirteen years as footway paving in London.

PEARSON, R. & J., High Street, Notting Hill, London, W.S.—Pearson's Patent Slow Combustion Open and Close Fire Kitchener, fitted with patented cast-iron cheeks and bottom through which the atmospheric air passes, and greatly increases the heating power of the range. This kitchener is intended to be used as an open fire range, and will thoroughly heat the roaster, oven and boiler, ventilating the kitchen, and considerably reducing the consumption of fuel; and it can be immediately converted into a close fire kitchener at will.

PHILLIPS, CHARLES D., Newport, Mon. (Agent, H. A. PRICE, 1 The Pavement, Clapham Common, London, S.W.)—The Coffee Pavilion, situated outside North Court, is covered with these patent tiles, the object of which is to produce a roofing tile that shall form a perfectly weather-resisting roof, and be impervious to wind, rain, or snow, and at the same time combining all the points necessary for an efficient roof, economical and ornamental. To attain this object, a system of grooves, with corresponding tenons, is formed on each of the four sides of the tiles, so that each tile shall lock into others on each side, top and bottom. The patentee also claims for his invention the novelty of the bottom of top tile butting against, or locking into its corresponding lower one.

PHILLIPS, W., & SONS, 10 Baker Street, Portman Square, W., have decorated various sections of the offices.

PUTNEY, ALFRED, Paddington, London, W.—The "Pavodilos" solid-wood flooring, is designed to remedy the many disadvantages of the ordinary nailed floor, and at the same time to produce a floor, together with borders of an ornamental description resembling parquét, at a cost very little exceeding that of an ordinary floor. The joints are so formed that each board can be screwed or nailed direct on to the joists through a tongue having an inclined and elongated surface, designed to give it (the tongue) greater strength and to permit of easy access for driving in screws or nails. An angle formed at right angles from the inclined surface of the tongue to the surface of the board, forms an important feature in the construction of the lock-joint; these angles having been specially designed to prevent their corresponding parts described as the shoulder (which is made to fit compactly over the inclined tongue) from rising or warping, thereby ensuring a perfectly even surface, hiding all traces of the nail or screw, forming a joint so close that it is not detectable, and a floor that can be removed and relaid as often as required without damage.

ROBINSON, VINCENT, & CO., 34 Wigmore Street, London, W., have supplied Carpets for the rooms set apart for the accommodation of the London and Provincial Press.

STARKIE, GARDNER, & CO., 29 Albert Embankment, London, have supplied Electric Light and Gas Fittings in wrought iron, brass and copper for the rooms provided for the accommodation of the London and Provincial Press.

STEEL & GARLAND, 15 Holborn Viaduct, London, E.C.—A Stove for use in one of the offices of the Exhibition.

STUART-WORTLEY, LIEUT.-COL. H., Rosslyn House, Trove End Road, London, N.W.—The principle of Colonel Stuart Wortley's Stove is to draw in pure air from outside a building or room into a heating apparatus or stove, consisting of a small box fixed to a larger distributing chamber, which small box is heated by gas, petroleum oil or other fuel. As the air passes through this small box a comparatively small quantity of gas or other fuel serves to heat the air drawn in to a very high temperature, and it afterwards passes into a larger chamber or into pipes for distribution. The products of combustion pass into a double skin, and away into a flue or chimney, and the base of the stove being open, foul air from the building or room is drawn in and passes away with the products of combustion.

THOMAS, J. J., 87 Queen Victoria Street, London, E.C., has supplied Orna-

mental Wire Fencing; also Wire Work Summer House.

TRELOAR & SONS, 68 & 70 Ludgate Hill, London, E.C.—Door Mats, made of unbleached coco-nut fibre, many of them with mottoes or words, such as "Salve," "Welcome," "Xaipe" worked in the centre. Treloars' mats were in use at the two former Exhibitions, and none of them were in any way worn out. This shows the durability.

UNITE, JOHN, 293 Edgware Road, London, W.—Awning for building set apart for use of the London and Provincial Press.

WARNER, JOHN, & SONS, Crescent Foundry, Cripplegate, London,

E.C., and the Foundry Works, Walton-on-the-Naze, Essex, have supplied a Bell, which is daily used for calling the workmen and attendants at stated times, and for various other purposes.

WILKES' METALLIC FLOORING CO., 17 Devonshire Square, Bishopsgate, London, E., have paved the street through "Old London" at much less than the cost price.

WRIGHT, Uxbridge Road, London, W., has supplied Ornamental Bricks for giving artistic effects.

LIST OF EXHIBITORS, ELECTRIC LIGHT DEPARTMENT.

* * DAVEY, PAXMAN, & Co. supply for this Department Five Engines and Eight Boilers.

No. of Section.	Name of Section.	Exhibitor.	Description of Dynamo.	Description of Lamps.				Description of Motive Power.	
				Name of Lamp.		Arc.				Glow.
				No.	C. P.	No.	C. P. V.		
1	South Promenade . .	R. E. Crompton & Co., Mansion House Bldg., 4 Queen Victoria St.	1 Crompton Btgin . .	Crompton	10	3000	...	"Tower" Spherical Engine	6 on 3 masts, and 4 at entrance. Lamps in series.
2	South Court (a) . . (b) Entrance Vestibule (c)	Edison Swan El. Lt. Co., 57 Holborn Viaduct.	Edison 2 Edison Hopkinson .	Swan Edison Swan . . . . .	... ... ...	... ... ...	... 80 400 50-46	Davey, Paxman, & Co. En- gines. Nos. 1, 2, & 3.	Fittings by E. Verity. Lamps in parallel.
3	Dining Rooms . . .	Paterson & Cooper, 76 Little Britain, E.C.	1 Phoenix, 36 unit . 1 " 12 " . 1 " 10 " . 1 " 14 " . 2 W 11 Siemens . 2 D Exciters	Bernstein . . . . .	... ... ... ... ... ...	... ... ... ... ... ...	... ... ... ... ... ...	D. P. & Co. Engines. No. & .	Lamps 2 in series.
4	Middle Court . . .	Siemens Bros., 12 Queen Anne's Gate, West- minster.	2 W 11 Siemens . .	Swan . . . . .	... ...	... ...	1080	D. P. & Co. Engines. No. & .	Lamps 4 in series.
5	North Court . . .	Anglo-American Brush El. Co., 112 Belvedere Road, Lambeth.	2 F 3 Victoria . . .	Victoria . . . . .	... ...	... ...	750	Kibson Parson High Speed Engines.	Lamps 2 in series.
6	Water Pavilion . . .	Goulden & Trotter, 2 Victoria Mansions, Westminster.	2 G. T.	W. & R. . . . .	... ...	... ...	300	D. P. & Co. Engines. No. & .	Lamps in parallel.
7	H.R.H. Pavilion. Con- servatory (b)	Elwell Parker, Commer- cial Road Works, Wol- verhampton.	2 E. P.	Swan W. & R. W. & R. . . . .	... ... ...	... ... ...	100 50 80	Elwell Parker High Speed Engine.	Worked in parallel, with 2 P. storage cells.
8	Old London Street . .	S. J. Mackie, Turk's Head Yard, Turnmill Street.	1 B Gramme . . . 2 A Grammes . . .	Swan . . . . .	... ...	5 3000	... 30 16-60	D. P. & Co. Engines. No. & .	Lamps in series. Glow lamps in parallel.
9	Old London . . .	R. E. Crompton & Co., Mansion House Bldg., 4 Queen Victoria St.	2 Crompton Btgin .	Woodhouse & Rawson	... ...	... ...	300	"Williams & Robinson" En- gine.	Lamps 2 in series. Fittings by B. Verity.
10	Engine Shed . . .	J. D. F. Andrews & Co., Woodside Electric Works, Woodside Rd., Glasgow, N.B.	2 Andrews	Andrews	20	700	...	D. P. & Co. Engines . . .	2 series of 10 lamps.
11	S. & P.'s Refreshment Bar and Grill Room.	Clarke, Chapman & Co., Victoria Works, Gateshead-on-Tyne.	2 C. C.	Gérard . . . . .	...	...	30	C. C. Turbine Engine . .	2 lamps in series.
12	Queen's Gate Annex .	Anglo-American Brush El. Co., 112 Belvedere Road, Lambeth, S.E.	2 Brush	Brush-Sellon . . .	24	3000	...	D. P. & Co. Engine . . .	2 circuits of 12 lamps each.
13	South Central Gallery .	Jablochhoff El. Lt. Co., 36 Albert Embank- ment, Lambeth.	4 Jablochhoff Gramme	Jablochhoff . . .	60	350	...	D. P. & Co. Engine . . .	Lamps arranged in 12 cir- cuits of 5 each.
14	West Arcade . . .	Gulcher El. Lt. Co., Bat- tersea Foundry, S.W.	2 Gulcher	Swan . . . . .	...	...	760	Coalbrookdale High Speed Engine.	Lamps in parallel.
15	East Arcade (a) . . Concert Room (b) B. Bar (c)	Gouldard & Gibbs, 18 Warwick Street, Re- gent Street.	... ... ...	Varley Malxim Swan	24	200 ... ...	... 50 80	D. P. & Co.	Lamps by induction bob- bins from one circuit.

No. of Section.	Name of Section.	Exhibitor.	Description of Dynamo.	Description of Lamps.					Description of Motive Power.	
				Name of Lamp.	Arc.		Glow.			
					No.	C. P.	No.	C. P. V.		
16	West Gallery . . .	Pilsen Joel El. Lt. Co., St. Stephen's Chambers, Telegraph Street, Moorgate Street.	4 Schlickert . . .	Pilsen . . .	42	700	...	...	D. P. & Co. Engines . . .	Lamps, 3 circuits of 14 each.
17	West Annexe . . .	Patersen & Cooper, 76 Little Britain.	2 Phoenix . . .	J. F. . . .	24	700	...	...	D. P. & Co. Engines . . .	Lamps, 2 circuits of 12 each.
18	West Central Gallery . . .	Cordiner Allen & Co., 20 Bucklersbury.	4 G. T. (Hallifax) . . .	Thornton S. N. & R. . . .	30	1000	...	60	D. P. & Co. Engines . . .	Lamps on 3 wire system 10 arcs, 20 glows, parallel on each machine.
19	East Central Gallery . . .	Maxim Weston El. Co., 32 Queen Victoria St.	2 Weston . . .	Weston . . .	25	2000	...	...	D. P. & Co. Engines.	Lamps all in parallel.
20	Central Gallery . . .	Glücher El. Lt. Co., Battersea Foundry.	3 Glücher . . .	Glücher . . .	50	1000	...	...	Westinghouse High Speed Engines.	Do. with "arcs."
21	Chinese Restaurant . . .	Glücher El. Lt. Co., Battersea Foundry.	(As above)	Swan . . .	...	...	250	16-45	As above . . .	In series.
22	Mast Light . . .	Goulden & Trotter, 2 Victoria Mansions, Westminster.	1 Hochhausen . . .	Hochhausen . . .	6	3000	...	...	D. P. & Co. Engine . . .	Used for the illumination of the fountains, being burnt in parallel arc.
23	Fountain . . .	Siemens Bros., 12 Queen Anne's Gate, Westminster.	1 Siemens Ditto. . .	... . .	12	...	...	...	D. P. & Co. Engines . . .	In series.
24	East Gallery . . .	Laing, Wharton & Down, 8 & 9 Holborn Viaduct, (Thompson Houston.)	1 Thompson Houston 1 . . .	Thompson Houston . . .	45	1000	...	...	D. P. & Co. Engines . . .	Used for the illumination of the fountains, being burnt in parallel arc.
25	East Annexe A . . .	E. Foix, 4 Orchard Buildings, Acton Street, Kingsland Road, E.	1 Oppermann . . .	Foix . . .	6	1000	...	...	D. P. & Co. Engines . . .	In series.
26	West Quadrant . . .	J. E. Statter, 37 High Street, Chelmsford.	1 Blügin . . .	Statter . . .	6	1000	...	...	D. P. & Co. . . .	In series.
27	East Quadrant . . .	Clark & Co., 411 Brixton Road.	2 Phoenix . . .	Clark-Bironau . . .	16	1000	...	...	D. P. & Co. . . .	In 2 series of 8 each.
27	Conservatory . . .	Siemens Bros., 12 Queen Anne's Gate, Westminster, S.W.	1 Siemens D . . .	Siemens . . .	4	6000	...	...	D. P. & Co. . . .	In parallel. #
28	Dual Dining Rooms (a) Austrian Court (b) Entrance Vestibule (c) Cascades (d) Club Dining Rooms . . .	Electric Sun Lamp Co., 6 Riding House Street, Regent Street, W.	2 Clerc Bureau . . . 2 Gramme (Exciters) . . .	"Sun" . . .	32	1200	...	...	D. P. & Co. . . .	On 4 circuits of 8 each.
29	Press Rooms and Etzenberger's Coffee Stall	Woodhouse & Rawson, 11 Queen Victoria St.	1 Elwell Parker . . .	W. & R. . . .	...	...	300	20-80	D. P. & Co. Engines . . .	Lamps in parallel.
30	S. & P.'s Temperance Refreshment Rooms	W. H. Allen & Co., York St. E. Works, York Road, Lambeth.	1 Kapp . . .	W. & R. . . .	...	...	180	16-50	"Tower" Engine. Allen High Speed Engine . . .	Lamps 2 in series.
31	Queen's Gate Entrance . . .	Consolidated El. Co., 67a & 68a Cow Cross Street, E.C.	1 Victoria (?) . . .	Consolidated . . .	...	...	250	16-60	... D. P. & Co. Engines . . .	Do. 4 In parallel E. T. K. system from accumulators.
32	S. & P. Tea Rooms . . .	Deakin, Parker & Co. Mather & Platt . . .	1 Siemens . . .	Siemens . . .	4	1500	...	...	... M. & P. High Speed Engine	Lamps in series.
33	S. & P. Cells . . .	Hathorn, Davey & Co. Property of Commissioners of Exhibition.	1 Mather & Platt . . .	Swan . . .	...	...	150	16-80	... "Davey" Motors . . .	Lamps in parallel.
34	Subway . . .		2 A Grammes . . .	Swan	80	10-45	... "Williams" Engine, "Obriek" Boilers.	Lamps in parallel. (Machine in Duplicate.)

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THE "OLD LONDON" STREET.

DESCRIPTION OF THE STREET REPRESENTING "OLD LONDON" IN THE INTERNATIONAL INVENTIONS EXHIBITION AT SOUTH KENSINGTON, 1885 (ERECTED FROM THE DRAWINGS AND UNDER THE SUPERINTENDENCE OF GEORGE H. BIRCH, ESQ., A.R.I.B.A., LATE HON. SEC. LONDON AND MIDDLESEX ARCHÆOLOGICAL SOCIETY).

THIS street is composed of various houses grouped together to form a quaint and picturesque thoroughfare of the normal width of an Old London street, the dates of the various buildings being as diversified as are their size and appearance, and the object that has been held steadily in view, is to show the City of London as it existed before the Great Fire of 1666 swept it from the face of the earth. These houses are no pasteboard and painted canvas delusions, but honest structures. They represent no fanciful restorations from written records, but are faithful delineations from actual drawings derived from authentic sources.

A reference to the accompanying plan will enable the visitor to identify the different houses and structures which are numbered as in the following description.

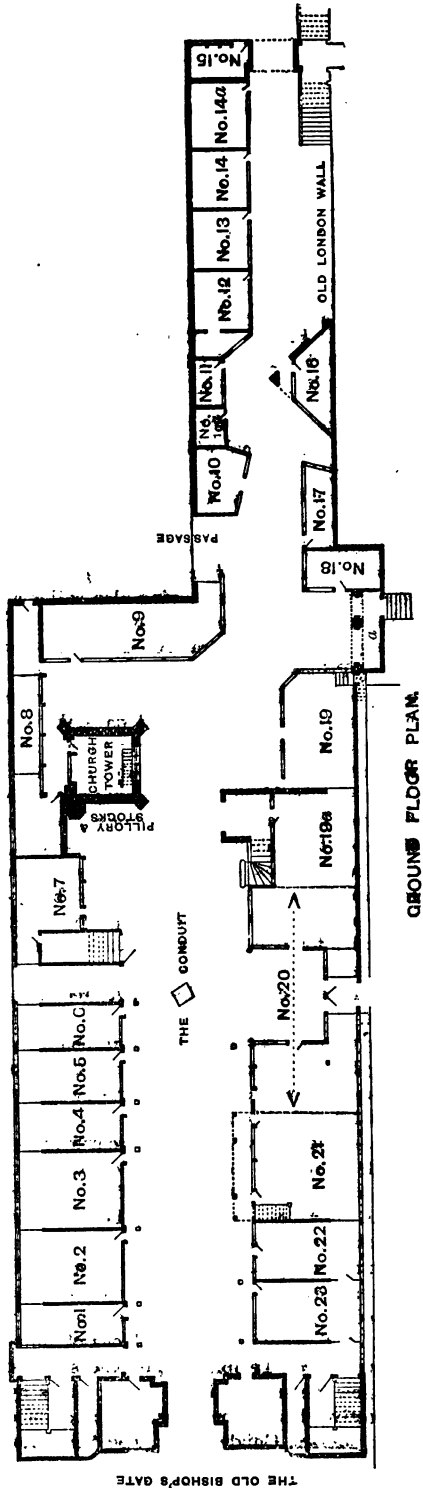
Entering from the Central Avenue immediately in front of the Pavilion of His Royal Highness the Prince of Wales, stands one of the City gates—Bishopsgate, reduced in proportion and flanked by the City wall; this gate (not one of the original gates of which there were but four) was broken through the ancient walls, the peculiar Roman manner of building with courses of tiles being shown on the lower part; these walls might have been built during the 400 years of Roman occupation, but more probably after their withdrawal and before the tradition of the Roman manner of building had died out; above the arch on each side are the arms of the City of London and the arms of the Bishopric, and immediately over the gate in a niche stands the statue of one of the bishops, William the Norman, to whom the City was particularly indebted, for by his good offices, all those rights and privileges and immunities which the City had inherited from Roman times and which had been confirmed and strengthened under the Saxons, were reconfirmed by the Conqueror. Once a year the City fathers went in solemn procession to his tomb in St. Paul's Cathedral, and testified by this act their grateful recognition. Above, on the towers which flank the gateway, are the statues of Alfred who wrested the City from the Danes, and of his son-in-law, Aldred Earl of Mercia to whom he committed the government thereof.

Passing through the gate the corresponding statue, that of William the Norman, is seen representing St. Erkenwald, the Fourth Bishop of London, A.D. 675, after the re-constitution of the see and re-establishment of Christianity by St. Augustine. This Erkenwald was a great favourite with the Londoners, and after his canonization, his shrine at St. Paul's, one of the richest in the kingdom, was for many centuries an object of great veneration. The ground floor on each side shows on the right a debtors' prison, and on the left an ordinary lock-up, and beyond are the staircases to the first-floor. After passing through the gateway, the first house on the left is the "Rose Inn" (No. 1), Fenchurch Street, curious as having its front covered with small cut slates, instead of the ordinary lath and plaster and timber construction usual in London.

The next house (No. 2) stood in Leadenhall Street, and was known as the "Cock Tavern," the representations of this house, of which there are many, represent it after the gable had been removed, and a flat coping substituted, but in this instance its pristine condition has been reverted to. Following in order is a block of three houses (Nos. 3, 4 and 5) formerly existing in Fleet Street, towards Temple Bar, on the south side, and known by the name of the "Three quirells," now Messrs. Gosling's Bank. This system of the houses being known by certain signs irrespective of the avocations, or change of owners, was universal. The "Marygold" at Temple Bar, Messrs. Child's Bank, The "Grasshopper" in Lombard Street, Messrs. Martin &

THE "OLD LONDON" STREET.

1. ROSE INT, FENCHURCH STREET.
2. COCK TAVERN, SOUTH SIDE OF LEADENHALL STREET.
3. "THE THREE SQUIRELS," FLEET STREET
4. DITTO.
5. DITTO.
6. ISAAC WALTON'S HOUSE.
7. HOUSES, BISHOPSGATE STREET.
8. PORTION OF BUTCHERS' ROW.
9. MIDDLE ROW, STRAND, GUNPOWDER PLOT HOUSE.
10. DUKE OF SCILL'S HOUSE.
- 10a. Old House, BISHOPSGATE STREET WITHIN.
11. DITTO.
12. Old House, GOSWELL STREET.
13. DITTO.
14. OLIVER CROMWELL'S HOUSE.
- 14a. HOUSE IN LITTLE TOWER HILL.
15. HOUSE, KING STREET, WESTMINSTER.
16. HOUSE IN LITTLE MOORFIELDS.
17. HOUSE CORNER OF HOSIER LANE, SHIREFIELD.
18. DITTO.
19. GATEWAY, HOLY TRINITY, ALDGATE.
20. FOUNTAIN LNS, MINORITA.
- 19a. HALL OF THE HOLY TRINITY, ALDERSGATE STREET.
20. WHITTINGTON'S HOUSE.
21. HOUSES IN BARKSIDE.
22. HOUSE, HIGH STREET, BOROUGH.
23. DITTO.



Co., and the "Golden Bottle," Fleet Street, Messrs. Hoare's, are all instances of a survival of a nomenclature the origin of which had been so entirely at variance with the avocations of the subsequent owners.

The house (No. 6) is a copy of the one which stood at the corner of Fleet Street and Chancery Lane, and was traditionally known as the "Isaac Walton's house." "*Vir et Piscator optimus*," but there is a doubt that tradition in this case was tradition only, as the actual house was two doors further to the west; but apart from this, the house itself was a magnificent specimen of an ordinary citizen's house in Elizabeth's reign, and was for many years a conspicuous ornament to Fleet Street, and in close contiguity to those well-known haunts of the wits of that period, the "Apollo" and the "Devil" Taverns.

Set back a little from the main line of the street in order to give prominence to Walton's house, and to give it the appearance of a corner house, are two unpretending wooden structures (Nos. 7 and 8) which formerly stood hard by the ancient church of St. Ethelburga, Bishopsgate Street, and were the ordinary type of hundreds of others in the old city, a shop below, and a solar or chamber above.

Standing prominently in advance of these is the old tower of a church, which, although not strictly modelled from that of All Hallows, Staining—differing only in having a larger traceried window—resembles in its general form and outline many others in which our forefathers were wont to worship; most of these churches were small, for the parishes attached to them were also diminutive, and this tower type, with bold octagonal staircase turret on one side, was almost universal; there were exceptions in which the towers had lofty pinnacles at each corner, like the present St. Sepulchre's, Holborn, or the more modern re-buildings by Wren, of St. Michael's, Cornhill, and St. Mary, Aldermanbury; and the curious arched superstructure with its five lanterns of St. Mary-le-Bow, or de Arcubus, and the very fine spire of St. Laurence Pountney; but the generality of the churches possessed towers similar in character to the one depicted here.

The water conduit (erected by Messrs. Judson & Co.), the pillory, and the stocks placed in the open space in front of the church tower are quaint and interesting features of the everyday life of our forefathers. This conduit stood at the junction of the four ways, Cornhill, Bishopsgate, Leadenhall Street, and Gracechurch Street, and was known as the "Standard upon Cornhill," and a well-known point for calculating distances from. The original had eight jets of water proceeding from the top of the Corinthian capital, but as the space at disposal was so limited these extra jets had to be omitted.

Next to the church, and fronting down the street, is a portion of the Middle Row (No. 9), which stood in the Strand, just outside Temple Bar, and was known as Butchers' Row; these houses well represent the overhanging of the stories so prevalent in London where the ground-floor space was very limited, additional room above being obtained by these means at the expense of light and air. Butchers' Row itself and its quaint structures were swept away when Alderman Pickett, with a public spirit far in advance of his times, made one of the first public improvements by widening this portion of the Strand, leaving the Church of St. Clement's Danes isolated in the midst of a large oval. These houses are historically interesting, as in one of them the Gunpowder Plot conspirators met.

Elbow Lane.—The site at this point considerably narrows, from 70 to 30 feet, and the houses are not continued on parallel lines, in order to break a perspective which would have been too long for a picturesque effect, and also in order to obtain that sinuosity so characteristic of London streets.

Next on the left is a fine large house of two gables (No. 10), which stood in this Middle Row, Strand, and was known as the French Ambassador's house, or the Duke of Sully's, also *Monsieur Beaumont's*, both ambassadors here from the Most Christian King to the Court of St. James'. This Duke de Sully was the famous Henri de Béthune, the wise and popular minister to Henri Quatre, King of France and Navarre. That this house was probably occupied by him there can be little doubt; not only from the commonly accepted tradition, but from the fact of its being decorated with badges of the De Béthunes, the French crown and fleur-de-lis, and two hands grasping one another in a true "*entente cordiale*."

The next (No. 11) is a low structure of wood and plaster, and has been modelled from an engraving representing a portion of Bishopsgate Street.

Beyond this is an old house (Nos. 12 & 13) which was in Goswell Street, of the date of Elizabeth's reign. The windows are mullioned and transomed, and show one peculiarity very general in old London, in carrying on the upper lights continuously.

No. 14 is a timber house with carved bargeboard, which stood next to Blue Boar's Head Yard, King Street, Westminster. The tradition as to its being formerly occupied by Oliver Cromwell was verified in 1833 by an inspection of the parish books of St. Margaret's, Westminster, where it was found that Lieut.-General Oliver Cromwell was rated for and occupied this house some time anterior to his taking possession of Whitehall Palace.

The last house (No. 14a), decorated with medallions of the Roman Emperors in plaster, stood on Little Tower Hill. There is nothing remarkable in the building beyond that the roof line is level and was chosen as a contrast to the all-prevailing gable.

At this point (No. 15)—the termination westward of the street—the entrance thereto is masked by one of the galleried fronts of an old London inn. The "Oxford Arms," Warwick Lane, was chosen as a typical specimen; but there are still remaining in Bishopsgate Street, Holborn, and more especially the Borough, several examples of these.

The house beyond (No. 16) was on the west side of Little Moorfields, Finsbury, and was a very fine specimen of plaster work. It was not removed until the commencement of the present century. A low building connects this with two houses (Nos. 17 & 18) possessing considerable interest; they stood at the south corner of Hosier Lane, Smithfield, over against the famous "Pye Corner," where the fearful conflagration of 1666 was arrested, after having laid considerably more than three-fourths of the City in ashes; they were not removed until 1800.

Another gateway here arrests our steps; this was the entrance to the famous Priory of the Holy Trinity, Aldgate, founded by Queen Matilda, and whose Prior, by virtue of his office as representing the Knighten Guild who had made over to this priory their lands and soke, was admitted as one of the Aldermen of London, of the Ward of Portsoken. According to custom, he sat in court, and rode in scarlet, or such livery as the other aldermen used. The Priory, at the dissolution, was granted to Sir Thomas Audley, whose daughter, marrying the Duke of Norfolk, gave the name to the house built by Audley out of the ruins of the Priory,—"Duke's Place." Beyond the gate (No. 19) is the inn called the "Fountain" in the Minories, which, notwithstanding its heavy projecting stories, was so strongly framed, that when it was attempted to remove it, cart-horses had to be employed to pull the beams apart; on one of them was found the date 1480.

Beyond this (No. 19a) is the gable end of the Hall of the Brotherhood of the Holy Trinity (which is reached by ascending the staircases to the first floor) in Aldersgate Street, near to Little Britain. This Hall has been selected as a typical example of the Hall of a Guild or Livery, of which there were many within the boundaries of the ancient City. It was a guild possessing property, and connected with the neighbouring church of St. Botolph's, Aldersgate Street, and after the suppression was purchased by some of the parishioners as a place of meeting. It was not removed until the end of the last century, and very accurate drawings by Capon and Carter exist in the Gardner Collection. Mr. Alderman Staples, F.S.A. (a member of the committee originally charged with the construction of the buildings), has given the history of this Guild in his 'Notes on St. Botolph's, Aldersgate.' The ancient stained glass with a figure of St. Blaise, and several ancient shields which existed in 1611, and were noticed by N. Charles, Lancaster Herald, have been faithfully reproduced.

The house beyond is one of the most remarkable in this street (No. 20), remarkable not only for its extreme richness of decoration, but as being connected with Sir Richard Whittington, famous in song and in story. It was situated four doors from Mark Lane in Crutched Friars, or Hart Street, up a courtyard, and was described in old leases as Whittington's Palace. Although the house from its style and ornamentation could not possibly have been of his time it is possible that the front only had been ornamented and altered, for in general outline and arrangement it resembled houses of that date—it was richly ornamented with carvings of the armorial bearings of the city companies, which stamped it as being the house of a remarkable personage and one whom the City delighted to honour. It was impossible to reproduce the extreme richness of its decoration. The ornamentation has therefore only been painted, the original having been entirely carved and painted and gilt. Very accurate prints of this court-

yard exist, and several views of the elevation more or less mutilated are in the European Magazine. An original drawing showing its gables is in the Gardner collection; from which this representation has been taken.

The next two houses (No. 21) were drawn by Mr. Gwilt before they were removed; they were situated in Bankside, and are picturesque examples of plaster decoration and open balconies.

The last two houses (Nos. 22 & 23) in this street on the left before arriving at the gate at which we entered were also from the Gwilt collection (now in the Gardner) and stood in the High Street, Borough; they were only removed of late years, and were drawn and measured by Mr. Gwilt.

As to actual size the whole of the buildings have only been slightly reduced, but this has been done in proportion, although such reduction is not to a uniform scale, but has been adopted in the different cases to suit the uniformity of the plan and arrangement of the whole. The interiors, it must be recollected do not in all cases correspond in size with the exteriors.

The foregoing notice is written from particulars furnished by Mr. Geo. H. Birch, the architect, and is not intended to be more than a very brief description of the examples selected to represent "Old London."

The buildings were designed and constructed as bearing upon and connected with the special objects of the International Health Exhibition, 1884, to which the Corporation of the City of London and several of the Livery Companies liberally subscribed.

Upon the transference of the numerous courts and structures which had contained the "exhibits" of the Health Exhibition to the Executive Council of the International Inventions Exhibition, 1885, that body resolved to retain the "street," and to adopt it as a special feature of attraction outside the general scope of a display mainly confined to productions of the last twenty-five years, and in any case not previous to the present century.

The exhibitors to whom the shops and rooms have been allotted this year were consequently selected with the object of providing as far as was practicable useful comparisons between ancient and modern handicrafts. The exceptions to this rule are very limited in number.

The plank flooring which covered the roadway last year, time not allowing of Mr. Birch's original idea for a pavement being carried out, has been replaced—under the direction of Mr. Wilson Bennison, architect and surveyor to the Council—by an appropriate pavement in imitation of the old style cobble stones and bricks which greatly adds to the antique appearance of the whole of the surroundings. Although the buildings remain substantially as in last year, improved access and means of communication with other parts of the Exhibition have been established.

The street is now illuminated at night by electricity, thus avoiding the necessity of closing it at dusk, as was the case last year. Both arc and crystal glow lamps are used; of the former kind, five Mackie lamps of 2500-candle-power each are so arranged as to produce the picturesque effect of moonlight in the street and narrow lane and alleys, while the shops and rooms upstairs are lit with 300 incandescent lamps by Crompton & Co., from two dynamos supplied by a 45-horse power Willan's high-speed engine.

The list of Exhibitors, with details of the processes and articles shown by them, is appended.

J. R. SOMERS VINE,
*City and Official Agent to the Exhibition, and Honorary Secretary
to the "Old London" Committee.*

GROUND FLOOR.

No. 1. NATIONAL HEALTH SOCIETY (THE), (Secretary, **MISS FAY LANKESTER**), 44 Berners Street, London, W.—Models, Books, Pamphlets and Leaflets bearing on Sanitary Questions; including a work specially compiled on "The Sanitary Conditions of Old London in relation to those of New London."

No. 2. W. H. GRANT, Foleshill, Coventry, Manufacturer of Fancy Silk Goods.—Silk Weaving, Ancient and Modern:—

(1) Old style of weaving by hand. Hand Loom in motion, weaving silk ribbons; wheel and spindle for filling; spools; collection of ancient fabrics made by hand. (2) Present method of weaving silk goods. One Jacquard Ribbon Loom, fitted with all the latest improvements, containing six tiers of shuttles; in motion, weaving high-class artistic silk goods, consisting of faithful views of buildings, scenery, portraits, in silk; woven music, &c. (3) Collection of silks, raw-thrown and dyed, showing the various stages of manufacture. (4) Collection of manufactured silk goods. (5) Various appliances connected with silk manufacturing.

No. 3. YE SIGNE OF YE 'ROSE AND SHAMROCKE [Trade Mark], Old London Street (**DONEGAL INDUSTRIAL FUND**, 31 New Cavendish Street, London, W.)—Formed by Mrs. Ernest Hart for the development of Irish cottage industries and for the benefit of the peasantry.—(1) Newly invented and specially designed art embroideries, Flax upon Flax, for all domestic purposes. (2) Native Cottage Fabrics, vegetable dyed, block printed, and hand embroidered designs. (3) Handspun and Woven Woollen Cloths. (4) Hand-knit Hosiery, vegetable dyed. (5) Innocuous Yarns. (6) Hand-wrought Embroideries on linen. (7) Hand-made Underlinens. (8) Lace, &c.

No. 4. JONES & WILLIS, 43 Great Russell Street, London, W.C., Art Metal Workers.—(1) Wrought-iron Gates, Panels, Gas Fittings, &c. (2) Polished Brass Gas Standards, for sanctuary and nave of churches. (3) Eagle and other Lecterns. (4) Memorial Brasses. (5) Silver Communion Plate. (6) Carved Stone and Marble Pulpit, Fonts, &c. (7) Carved Oak Eagle Lectern, Stalls, Chairs, &c. (8) Hesperus Lamp Fittings.

No. 5. POTTER, H., & CO., 30 Charing Cross, London, S.W., Musical Instrument Manufacturers.—(1) The process of turning and finishing flutes and other wooden reed instruments. (2) A few ancient musical instruments.

No. 6. LOCH BROTHERS & CO., 35 Queen Victoria Street, London, E.C. (Works, Rochester and New Cross),

Engineers and Manufacturers.—(1) Manufacturing processes in various kinds of sheet metals. (2) The process of manufacturing patent air lamps and various kinds of patented inventions; also an instantaneous water-boiling apparatus, that will boil water without coals, gas, or lamp of any description. (3) A Chinese Kettle for the dining-room with which to boil water. It is not placed on top of the fire, but thrust in between the fire-bars, and thus boils the water in an incredibly short space of time. (4) The process of manufacturing tin canisters. (5) Workmen engaged manufacturing the above, as follows: Planishing, brazing, coppering, tinning, shearing, punching, stamping, folding, wiring and bending, and making seams in different metals, with the assistance of hand-power machines.

No. 7. BETJEMANN, G., & SONS, 36, 38, & 40 Pentonville Road, London, N., Manufacturers of Fancy Goods.—(1) Process of manufacturing Bramah and other Locks. (2) Ornamental and Heraldic Engraving. (3) Fancy Cabinet-making.

No. 8. LANCELAND, WOOD, & CO., The Avenue, Acton, London, W.—(1) The Wing Lock. This invention prevents straying, cheapens fencing, keeps breeding hens pure, and, by its means, economical-feeding breeds of fowls may be safely kept in hand; not injurious to the plumage. Contrasted with the ancient methods of confining birds used, in falconry. (2) The New Egg-Oven "Bifrons," with Improvements of 1885. This hatching-oven is an English invention, distinctly adapted to our climate. The recent improvement is preventive of the dry metallic character of the artificial heat. (3) The Brooder, for rearing machine-hatched young, has, together with other advantages, two climates. The methods of nature are pictorially contrasted with those of recent machine work.

No. 9. STARKIE, GARDNER, & CO., 29 Albert Embankment, London, S.E., Art Metal Workers.—(1) Lamps for gas, oil, and electric light, for every kind of domestic and ecclesiastical lighting. (2) Window Grilles, Door-Handles, Latches, Grates, and every description of Hammered and Wrought Iron, Copper, and Brass Work. Every piece is directly produced by a trained artisan, by hand, without machinery, and two or three pieces only are made to each design.

No. 10. EDGINGTON, BENJAMIN, 2 Duke Street, London Bridge, London, S.E., Tent Maker.—(1) Drawings and Engravings of tents and tent-making, ancient and modern. (2) Models of Modern Tents, British, Foreign, and Indian. (3) Illustrations of recent improvements in form and construction.

No. 11. FRANKS, L., 1 & 2 Hutchison Street, Aldgate, London, E.—The Handicraft of Marqueterie and Fretwork, in ancient and modern styles, with tools and designs for same.

No. 12. GILDING & SILVERING CO. (THE), (S. GORER, Manager, 118 Edgware Road, near Burwood Place), 1 Waltham Buildings, Holborn Circus; Steam Works: Diana Place.—(1) Electro Platers by the new dynamo process. (2) Nickel Depositors. (3) Electro-plating by patent process. (4) Comparisons shown between the old process of close plating and modern methods. (5) Mat and Mercurial Gilding by process, and collection of specimens of old work.

No. 13. ROMBACH, HERBERT M., 21 Spring Street, Paddington, London, W., Medal Stamper.—“Ye olde London medal stamping presse;” medals of the “Old London” street; the machinery for the manufacture thereof, in motion.

No. 14. HORWITZ & GORER (Mesdames) 24 Waltham Road, St. Peter's Park, London, W., Lace Manufacturers.—The manufacturing of lace goods for the encouragement of home industry.

No. 14a. DAVIS, JOS., & CO., Fitzroy Works, Kennington Park Road, London, S.E.—Meteorological and Scientific Instruments, and the process of manufacture.

No. 15. HUMPHRIES, ROBERT, 52 Seymour Place, London, W., Manufacturing Silversmith, Gilder and Plater, Working Jeweller, and Diamond Mounter.—Above trades in operation.

No. 16. GAWTHORP, THOMAS JOHN, 16 Long Acre, London, W.C., Engraver and Brass Worker.—(1) Engraver at Work; Examples of Carving in Brass; Memorial with portrait of the late Colonel Burnaby, various Carved Brasses, &c. (2) Examples of Engraving; Ancient Brasses and Rubbings, Modern Brasses and Rubbings. (3) Specimens of Engraved and Beaten Brass, Alms Dishes, Salvers, Trays, &c. (4) Improved Brass Door Furniture. (5) Collection of Photographs, Drawings, &c., relative to the above.

Nos. 17 & 18. GILLET & CO., Whitehorse Road, Croydon, London.—(1) Astronomical Clocks, Regulators, Chiming and Musical Clocks. (2) Clocks for offices, class-rooms, railway stations, post offices, &c. (3) Patent Chronoscope for showing the time as indicated in the railway time tables, also their Patent Chronoscope for showing the time from 1 to 24 o'clock; several ancient clocks over 200 years old; cut gun-metal wheels showing the different angles of teeth required in turret and other clocks, and carillon machines. (4) Workmen and Tools employed in the construction of modern clocks, &c. (5) A Working Model of the Patent Carillon Machine, playing seven tunes on each barrel, the barrels being interchangeable.

No. 19. WATERLOW & SONS, Limited, 25, 26 & 27 Great Winchester Street, E.C.; Finsbury Stationery Works, &c., Bank-note and General En-

gravers, Die Sinkers, Printers, Lithographers, &c.—(1) Copper-plate Printer at Work, printing etchings of views of the Old London Street, etched by Thomas Riley, and other etchings or general plate work. (2) Specimens of Bank-notes, Postage and Revenue Stamps, and various Artistic Commercial Engraving and Process Printing. (3) Die Sinker and Embosser at work, sinking and embossing address dies, monograms, &c. (4) Specimens of Die Sinking and Medal Engraving.

No. 20. LITCHFIELD, SAMUEL, 3 Bruton Street, Bond Street, and 28 & 30 Hanway Street, London, W., Upholsterer, Decorator, and Importer of Works of Art.—(1) *Entrance Hall*, with carved oak settee and figures of the 16th century. (2) *Frontage*. The Process of Wood Carving as carried on by the mechanics of the 16th century. (3) *Interior*, fitted as a Parlour. Same period. Carved furniture. The process of carving, and its adaptation to the uses of the furnishing and decorative art.

No. 21. ELKINGTON & CO., 22 Regent Street, S.W., and 42 Moorgate Street, London, E.C.; and at Birmingham, Liverpool, and Manchester, Manufacturing Silversmiths, original Patentees of the Electro Plate, and Art Workers in the Precious and other Metals, Bronzes, &c.—(1) Patented Processes of depositing gold, silver, and other metals, and the various systems used for the reproduction of art objects. (2) Specimens of their several manufactures in gold, silver and electro-plate, and reproductions of art objects.

No. 22. BLAXALL, SON, & CO., 45 Great Ormond Street, London, W.C., Manufacturing Confectioners.—Old English Sweetmeats, American Caramels, Candies and Rocks, Japanese Coconut, French Fondants and Pastilles, Turkish Delight, &c.

FIRST FLOOR.

No. 1. NICHOLS, F. S., & CO. (S. DREWETT), 14 High Street, Borough, London, S.E., Printers and Publishers.—Paintings, drawings, engravings and etchings illustrative of England in the olden times; old English manners and customs; coaching days; our forefathers' recreations; mediæval architecture; antiquities; country life and rural sports. London before and after the fire of 1666; maps, plans and charts.

No. 2. MACKMURDO & HORNE, 28 Southampton Street, Strand, London, W.C.; and at Liverpool.—Music room, showing character of their design in furniture, stained glass, decoration, wall papers, stuffs, carpets, metal-work, &c.

No. 3. FIELD & TUER, The Leadenhall Press, 50 Leadenhall Street, London, E.C., Printers and Engravers.—(1) An

extensive series of old-fashioned Copperplate Engravings of the last century by Bartolozzi and his school, known as "Our Grandmothers' Prints." (2) The process of copperplate printing as carried on a hundred years ago. (3) Quaint books, prints, &c.

No. 4. FEETHAM, MARK, & CO., 9 Clifford Street, London, W., Stove Makers and Art Metal Workers.—(1) A complete historical display of English domestic fire-places, with various household implements of art design connected therewith. (2) Artistic representation of characteristic English iron-work.

No. 5. FEETHAM, MARK, & CO., 9 Clifford Street, London, W.—(1) Stove-makers' workshop. (2) Process of manufacture affording comparison between antique and modern work, and the improved method of production.

No. 6. JONES & WILLIS.—*See Description of Shop No. 4 on the Ground Floor.*

Nos. 7 & 8. ELLIOTT, JAMES, 13 Langham Street, London, W.—(1) Hangings of velvet for ecclesiastical and domestic purposes, decorated by "Lustra" painting in iridescent metals. (2) Work shewn in operation.

No. 9. WILSON & BLESSLEY, 1 Paul Street, Finsbury, London, E.C., Metal Workers.—(1) The process of raising, chasing, and repoussing nickel, brass, copper, and bronze, and forming them into useful articles by raising and planishing with the hammer only. (2) Lathe Turning.

No. 10. SALVIATI & CO., 213 Regent Street, London, W., Manufacturers of Venetian Glass, Enamel, Mosaics.—(1) Ancient and modern systems of manufacture. (2) Table and ornamental glass from the time of Queen Elizabeth to the present day. (3) The manufacture of Venetian beads and glass chandeliers. (4) Special appliances for gas and electricity. (5) Venetian mirrors.

No. 11. SCOTT, CUTHBERTSON, & CO., Whitelands, Chelsea, London, S.W.—Wall Paper Printing.

FIRST FLOOR GALLERIES AND RECESSES.

SALOMON, A., & CO., 28 High Street, Whitechapel, London, E.—Ancient and Modern Army and Navy Boots and Shoes.

SLAZENGER & SONS, 56 Cannon Street, London, E.C.—Collection of India-rubber Goods.

MARTIN, C., Sevenoaks, Kent.—(1) Antique Carved Oak Cabinet, formerly in Hever Castle, Kent. (2) Very Old Inlaid and Lacquered Cabinet, of Japanese workmanship, imported into this country nearly a century ago.

NICHOLS, C. E., 33 Edgware Road, London, W.—The process of stamping leather, paper, and other materials, and manufacturing fancy articles therewith.

KING, JOSEPH, & CO., 168 Adrian Terrace, London, S.W.—(1) A Curious Chime Clock, 4 ft. 8 in. high; 2 ft. 3 in. deep; 3 ft. 4 in. wide; elaborately ornamented; fitted with chimes and mechanical working figures. (2) Silversmiths' Work.

THOMPSON, H., & CO., 95 Merrow Road, Walworth, London, S.E.—Magnetic Oxide of Iron Paints.

CARRUTHERS, C. W., 20 River Street, Myddelton Square, London, E.C.—An invention showing the use that is made of the cinder refuse of iron blast furnaces, known as "slag."

ROYAL RUBBER CO. (THE), 166 Sloane Street, London, S.W.; Works, Barnsbury.—Vulcanised and ordinary India-rubber Goods.

SILICATED CARBON FILTER CO. (THE), Church Road, Battersea, London, S.W.—(1) Silicated Carbon Filters and Field Service Filters of various systems. (2) Filtration past and present.

WEBSTER BROTHERS, 4 Portchester Road, Bayswater, London, W.—Two Screens. Specimens of the gelatino, bromide, and carbon processes on paper, opal, and ivory.

THE CHURCH TOWER.

GILLETT & CO., Whitehorse Road, Croydon, near London.—(1) Turret clock, with patent *remontoire* train, double gravity escapement, and improved winding gear. (2) Ancient and modern bells. (3) Carillon Machine and Chiming Apparatus.

THE CONDUIT.

JUDSON, DANIEL, & SON, 77 Southwark Street, London, S.E.—An "Olde Water Conduit," bearing sundry quaint inscriptions.

THE AQUARIUM.

THE success that has attended this permanent section of the late International Exhibitions since its inauguration in 1883 has raised it indubitably in the high estimation of public regard and appreciation.

It will be remembered that after the termination of the International Fisheries Exhibition the control of this Department was placed in the hands of the National Fish Culture Association, having for its President and Chairman the MARQUESS OF EXETER; for its Vice-President, EDWARD BIRKBECK, Esq., M.P.; and for its Director and Secretary, Mr. W. OLDHAM CHAMBERS, F.L.S.; and the following noblemen and gentlemen on its Executive Council:—

THE MARQUIS OF LORNE, K.T.
THE EARL OF ROMNEY.
THE EARL OF ANNESLEY.
THE EARL OF DONOUGHMORE.
MAJOR-GENERAL LORD ABINGER, C.B.
THE RIGHT HON. SIR W. HART-DYKE, BART., M.P.
SIR JOHN ST. AUBYN, BART., M.P.
SIR P. DE GREY EGERTON, BART.
THE PRIME WARDEN OF THE FISHMONGERS' COMPANY.
THE MACLAINE OF LOCHRUY.
T. ANDREWS, Esq.
R. BARCLAY, Esq.
C. BATES, Esq.
J. BRUNTON, Esq., M.D.
W. BURDETT-COUTTS, Esq.
J. H. CROSSMAN, Esq.
LIEUTENANT-COLONEL CUSTANCE.
H. FENNELL, Esq.

FRANCIS FRANCIS, Esq.
C. E. FRYER, Esq.
P. GEEN, Esq.
DR. GÜNTHER, F.R.S.
PROFESSOR HUXLEY, P.R.S.
A. G. JARDINE, Esq.
H. LEE, Esq., F.L.S.
REV. J. J. MANLEY, M.A.
T. J. MANN, Esq.
R. B. MARSTON, Esq.
O. T. OLSEN, Esq., F.L.S.
J. L. SAYER, Esq.,
LIEUTENANT-COLONEL SEDDON.
W. SENIOR, Esq.
S. B. SHARPE, Esq.
T. SPRECKLEY, Esq., Chairman, Thames Angling Preservation Society.
J. WILLIS BUND, Esq.
LIEUTENANT-COLONEL STUART WORTLEY.

During the International Health Exhibition last year the Aquarium was thronged with spectators throughout the day, taxing to the utmost the accommodative capacity of the building. To the British public there is a fascination in watching the graceful silent movements of the inhabitants of our waters; and no matter what form an exhibition may take, a glimpse into the oceanic world is always heartily welcomed, especially by those who have never beheld the sea itself. Although the exhibitions that have succeeded that of the International Fisheries, when the Aquarium was built, have been of an entirely different character, a collection of fish, such as that now on view, will prove a gratifying and popular feature not only to naturalists and scientists but to all communities.

The Council of the National Fish Culture Association have spared no trouble and expense to still further heighten the attractiveness of the Aquarium, and preparations have been in course of progress since the beginning of the present year for bringing to perfection the several necessary preliminaries, to ensure the successful retention of fish in captivity. During the winter the Aquarium was maintained in such a manner that the collection now shown to the public might include as many well-seasoned and matured fish as possible. Elaborate arrangements have been made for replenishing the tanks with marine and fresh-water fish, and to this end special trawlers are being employed on all parts of the coast to capture and forward specimens, so that the Aquarium may always be replete with carefully selected fish, forming a unique display as far as London is concerned.

In order to still further intensify the interest attaching to the living collection of fish, the Council of the National Fish Culture Association obtained the consent of the Lords of the Committee on the Council of Education to a portion of the magnificent exhibits in the Buckland Museum being transferred to the Aquarium for exhibition. An excellent show of interesting and edifying objects are thus presented to the public conjunctively with the inhabitants of the tanks, forming a rare and important combination of exhibits hitherto rarely excelled.

FISH CULTURE DEPARTMENT.

THIS section of the Exhibition, belonging to the National Fish Culture Association, is situated in the Western portion of the building, and runs parallel with the Aquarium, containing exhibits of fish-hatching and rearing apparatus invented by the Marquess of Exeter and Mr. W. Oldham Chambers. During the winter and spring this department has been a scene of lively activity, on account of the spawning season, when many hundred thousands of fish eggs were successfully incubated, and the fry transferred to waters at the Delaford Park Fishery belonging to the Association. It is to be regretted that, on account of the time of year, the public were prevented from viewing the hatching operations, which were of a most interesting and instructive character.

In regard to the Exhibits contained in this section, on one side is to be seen a tank of large proportions, in which magnificent specimens of salmonidæ of various species, including grayling, are shown, whilst on a line with it is a row of hatching boxes, in which ova are deposited and the fry maintained until such a time as they lose their *umbilical sac*. Exactly opposite are several tanks in which are exhibited some of the fry hatched last year on the premises, including salmon and trout, which are interesting as affording an idea of the capacity of artificial fish culture. Among other Exhibits are a model of an Oyster Culture Establishment designed by the Marquess of Exeter, models of Fish Culture appliances designed by Livingstone Stone, Esq., H. C. Chester Esq., M. G. Holton, Esq., W. H. Wroten, Esq., and a model exemplifying the most efficacious and economical method of constructing breeding ponds for fish, invented by Mr. W. Oldham Chambers, F.L.S., all of which are well worthy of note, forming, as they do, edifying and interesting studies, selected from the Buckland Museum.

Rarely has such a diversified combination of fish in all stages of development, together with appliances and apparatus for hatching and rearing the fry, been brought together for the purpose of convincing the public as to the practicability of increasing the fish food supply of the nation by the exercise of scientific principles and manipulation. A lucid ocular demonstration of the manner in which pisciculture can be successfully and thoroughly prosecuted is thus afforded, whereby all theoretical dogmas become exploded, and dubitancy is erased from the mind of the sceptic by undeniable proof.

The Council of the National Fish Culture Association are desirous of acknowledging the following special services that have been rendered in the Aquarium and Fish Culture Establishment, and have much pleasure in testifying to the uniform acts of courtesy and kindness which have been so liberally accorded to the Council in their endeavours to make this Department attractive and instructive to the public.

COMPLIMENTARY LIST.

ANDREWS, THOMAS, Westgate House, Guildford.—Contributions of trout fry to the Fish Culture Department.

BARTLETT, W., & SONS, Redditch. London House, 53 Gresham Street, E.C.—For exhibits of fish hooks, lines, fishing rods and tackle in the Aquarium.

BAIRD, THE HON. SPENCER, Washington, America.—Contributions of salmon, trout, and coregonus eggs to the Fish Culture Department.

BEDFORD, K.G., THE DUKE OF.—Contributions of fish to the tanks of the Aquarium.

BUSSELL, CHARLES GIBBS & CO., Glass Warehouse, 75 Wells Street, Oxford Street, London, W.—For fifteen glass fish aquaria and globes and two corner fish tanks, with silvered plate glass wall surfaces at back, for use in the Aquarium.

JOSEPH DAVIS & CO., Manufacturing Opticians, 8 Kennington Park Road, London, S.E.—For supplying free of cost to the Aquarium and Fish Culture Department, their Royal Polytechnic barometers, thermometers, and other scientific instruments.

DICK RADCLIFFE & CO., 128 High Holborn, W.C.—For decorating the entrance of the Aquarium with a fernery and palm trees, and supplying small freshwater tanks and ferneries.

EXETER, THE MOST HON. THE MARQUESS OF, Bursleigh Park, Stamford.—For supplying various freshwater fishes to the tanks, hatching and rearing appliances, models and microscope for use in the Fish Culture Department.

GEE PATENT AUTOMATIC FOUNTAIN CO. (THE), 150 Leaden-

hall Street, London, E.C.—For supplying patent automatic fountains in the Fish Culture Department for ornamental purposes. These fountains work independently of any direct supply, being entirely self-contained.

HUMPHREYS, J. CHARLTON, Albert Gate, London, S.W.—For erecting upon his portable principle the corrugated iron building for the use of the Board Room and Secretary's offices adjoining the Aquarium.

JEX, EDWARD, C.C., 27 St. Mary-at-Hill, E.C.—For providing and fitting up specially constructed tanks for use on board his smacks and carrier steamers for the purpose of supplying live marine food fishes to the Aquarium.

LITTLE, G., & CO., 15 Fetter Lane, London, E.C.—For exhibits of fishing rods and tackle in the Aquarium.

LUBBOCK, REV. H. H., Hanworth Rectory, Norwich.—For his assistance in supplying fresh-water fishes to the Aquarium and spawning fishes to the Fish Culture Department.

MAIGNEN, P. A., 22 & 23 Great Tower Hill, London, E.C.—Has supplied his patent Filtre Rapide for the purification

and softening of the fresh-water tanks in the Aquarium and Fish Culture Department of the Association. The sea water has also been clarified by one of his large supply Filtres Rapides, which last year was used for the same purpose.

POLAND BROTHERS, Lower Thames Street, London, E.C.—For a continuous supply of living crustaceans to the tanks and specimens in spawn for the Fish Culture Department.

SAYER, J. LAST, C.C., Lower Thames Street, London, E.C.—For a supply of live marine fishes to the tanks.

SUFFIELD, THE RIGHT HON. LORD, K.C.B., Gunton Park, Norfolk.—For a constant supply of live fresh-water fishes to the tanks and spawning fishes to the Fish Culture Establishment.

TABOR, G., Lower Thames Street, London, E.C.—For a supply of molluscs to the tanks.

WILLIAMSON, W. H., C.C., Lower Thames Street, London, E.C.—For a regular supply of molluscs and crustaceans to the tanks and to the Fish Culture Department.

GARDEN AND HORTICULTURAL EXHIBITORS.

CUTBUSH, W., & SON, The Nurseries, Highgate.—Ornamental Trees and Shrubs.

FROMOW, W., & SONS, The Nurseries, Chiswick.—Ornamental Trees and Shrubs.

LANE, H., & SON, The Nurseries, Great Berkhamstead.—Collection of Rhododendrons.

PAUL & SON, The Old Nurseries, Chessington, Herts.—Ornamental Trees and Shrubs, Rock Plants, and Roses.

PAUL, WILLIAM, & SON, Paul's Nurseries, Waltham Cross.—Roses and Ornamental Plants in Messrs. Pearson's Greenhouse.

PULHAM, JAMES, Broxbourne, Herts.—Ornamental Rock Work.

TURNER, C., Royal Nurseries, Slough.—Collection of Ivies in pots.

WARE, T. S., Hale Farm Nurseries, Tottenham, N.—Collection of Dahlias and other Plants.

WATERER, ANTHONY, Knap Hill Nurseries, Woking.—Collection of Rhododendrons and American Plants.

YOUNG, MAURICE, Milford Nurseries, Godalming.—Collection of Rhododendrons, &c. Garden and Prince's Pavilion.

DIVISION I.

INVENTIONS.

AGRICULTURE, HORTICULTURE AND ARBORICULTURE.

By H. M. JENKINS, *Secretary of the Royal Agricultural Society of England.*

A BRIEF introduction to the new inventions exhibited in Group I. can only be an attempt to indicate the general character of the track which has been explored during the last quarter of a century by the inventors of machines and improvements applicable to the productive arts mentioned at the head of this preface. The object of the inventor is to meet the acknowledged twofold desire of his clients, which is, first of all, to improve the quantity and quality of their products, and secondly, to diminish as far as possible the cost of their production. Human labour is the dearest of all motive powers, horses come next in the scale, and steam is at present the cheapest of those which are under the control of the farmer, the gardener, and the forester. The employment of both wind and water as motive powers is very economical, but as they are both more or less uncontrollable forces, they can only be safely used as adjuncts to the more expensive but more reliable ones. Up to the present time attempts to utilize gas and electricity, as motive powers on farms, have not brought them within the scope of practical agriculture.

The displacement of human labour in agriculture within the limits of Great Britain, owing to improvements in machinery, has been made clear by the last census, which shows that both farmers and labourers have each decreased about ten per cent. in their relative numbers during as many years. But within the same period the number of proprietors of agricultural machines let for hire, and of the attendants upon them, had nearly doubled, and had increased from 55 in 1851 to 1441 in 1861, to 2160 in 1871, and finally to 4260 in 1881. Such figures as these may be correctly described as "speaking."

It must be stated, however, what has not escaped the notice of the Executive Council of this Exhibition, that the use of agricultural machinery in Great Britain is fostered by the shows and the competitive trials of the Royal Agricultural Society of England, the Highland and Agricultural Society of Scotland, and the larger County and District Agricultural Societies. Five miles of shedding filled with implements at a "Royal" show is an annual exhibition which illustrates the extended use of machinery in the operations conducted in the field and on the farm, and has rendered unnecessary the apportionment of a very large space at this Exhibition to a multitude of inventions which are for the most part already well known to those most interested in them.

The progress of invention during the last twenty-five years has, in the case of agricultural machinery, taken two well-defined directions, namely—

- (1) The improvement of old types of machinery.
- (2) The invention of new types.

In the first group of inventions nearly every agricultural implement has been improved, either with a view to obtain increased efficiency, or for the purpose of ensuring greater economy in manipulation. It would take more than the space at my command to enumerate as a mere list the ingenious contrivances which have been introduced for these purposes alone. Another class of improvements was in the first instance forced upon manufacturers and farmers by public opinion, and subsequently by the legislature; this is, in general terms, efficient protection against accidents to the persons employed in working agricultural machinery. I am not aware that there is any precedent for the action of the House of Commons in delaying legislation for the express purpose of having before it the results of competitive trials promoted by a Society unconnected with the Government. This course, however, was adopted about twelve years ago, in the case of proposed legislation as to the protection of men employed to feed threshing machines, which is now done automatically by skilfully designed mechanical feeders. As another illustration I may mention that numerous ingenious devices have been patented to protect the persons employed in feeding chaff-cutters, especially those which are driven by steam. The general principle which has been aimed at, in both cases, is the construction of such a guard

that the least obstruction would immediately and automatically stop the machine, and thus prevent damage to the obstruction in the case of a man's hand, and damage to the machine in the case of a stone or a piece of iron, or other inorganic obstacle.

The marvellous improvement which has taken place during the last quarter of a century in all agricultural steam engines, whether "fixed," or "portable," or "locomotive," is so great that it requires a long course of study of the past and present machines to enable one to realize it; and the march of invention has not yet been arrested, as the shows of the Royal Agricultural Society bear witness year by year. Simplicity of construction, economy of combustion, diminution of friction, and efficiency of control, seem to be the points which are aimed at in agricultural engines; and some of them, of course, contribute to the attainment of that high "duty," which is legitimately the boast of our agricultural engineers.

In steam-ploughing machinery the progress has been no less remarkable, and innumerable have been the devices tried with the same view as that which has stimulated inventors in other classes of agricultural machinery, namely, to save manual labour and to increase the efficiency of work done. As in other fields of investigation and invention, there are greater or less failures that might be recorded; and the various attempts to construct a practical steam-digger may be divided amongst the hopeful and the hopeless. Of late years the combination of a sheaf-binder with a reaping-machine has attracted very much attention; and at last we may fairly lay claim to possess such machines capable of binding corn with string, and suitable for English crops. The farmer can thus dispense with wire, which was the original and objectionable binding material, and this latest development of the sewing machine may now be regarded as quite practical if not absolutely perfect.

The invention of new types of agricultural machinery has been very fruitful during the period under review, and although it may be a debatable question what this class of machinery is to include, yet in a short preface a little latitude may be allowed. Let us take for instance the "straw-elevator," or, as it is equally termed, the "stacking machine," the straw-burning steam-engine, the steam-driven reaper, and the automatic sheaf-binder—all new types of machines invented during the last quarter of a century. I feel tempted to say that if the highly imaginative author of '*Paris en Amerique*' had been an agriculturist, he would have described in the most eloquent language some such picture as the following:—Imagine a wheat-field in the boundless lands of the new continent; the crop is cut by a steam-driven reaping machine fitted with a sheaf-binding apparatus; the motive power is furnished by a steam locomotive engine, which uses as fuel the straw which carries the heads of grain, and for which there is no other use in these regions—it must either be burnt to waste in the open, or to a useful purpose in the steam-engine. Then what else do we find? The engine pushes before it the reaper and binder, but it also drags after it the waggons to convey the sheaves to their destination and the water-supply for the boiler. Arrived at the threshing machine the waggons tip the sheaves into the receiver of the elevator, which conveys them to the automatic feeder of the threshing machine, and the waggons are immediately refilled with straw to feed the engine with fuel during its next to and fro journey. Such a picture could of course only be realised on the mammoth farms of America, of Austro-Hungary, and other regions where agriculture is pursued on a colossal scale; but such a combination of farm implements could be arranged in England at the present day.

Another combination of new machinery has recently been devised for dairy factories. In place of the old and tedious method of setting milk in pans or pails so that the cream may rise in a certain number of hours, and then be skimmed off in order to be made into butter, we have now the following remarkable series of performances by implements of recent invention. The milk having arrived at the factory in what are termed "Railway Churns," is weighed either on a weighbridge or by a special machine as it is hoisted to the required floor of the factory. It is then, by one of the ingenious adaptations of the well-known sack-lifter, elevated and tipped, and its contents discharged into a large vat. From this vat the milk finds its way into a cream separator being submitted on its passage to such alterations of temperature and modifications of flow as may be deemed necessary, through the agency of small intermediate adjuncts. Arrived at the separator the milk is submitted to a centrifugal action at a high speed, with the result that the cream flows out through one spout and the skim-milk through another. But mechanical science has not stopped here, for the cream can easily be turned directly into a churn, and the skim-milk elevated by the mere motion of the separator so as to enable it to be passed through a machine

either to cool it or warm it as may be desired. The result is that, given the milk delivered at a dairy factory, it can be resolved into butter and cheese by these means in the course of between two and three hours, and thus the "nimble ninepence" has found its equivalent in agriculture. I do not mean to say that the cheese is immediately available for sale; but on this system, coupled with recent methods of cheese-making, I think, with due respect to the late Canon Girdlestone, that the "maggots" would not arrive before the "men."

A remarkable addition to the minor utensils of the dairy, about which Danes contend with Americans for the honour of its discovery, is the Mechanical Butter-worker, and I ought also to mention the system of deep-setting milk, invented by Mr. Swartz (a Swediah farmer), if only to enable me to state that it has revolutionized butter-making in the north of Europe, and has created a school of imitators in America. An almost equally remarkable series of agricultural machines which have been introduced during the last twenty-five years are those known collectively as "chicken raisers." Of these there are two classes—one designed to hatch the eggs without the aid of the hen, and the other to rear the chicken in an equally independent manner. From the original conception of a box heated in a more or less perfunctory manner, the progress of invention has been marked by the introduction of hydro-incubators, thermo-incubators, and a variety of other hatching machines, until now we are told that by the aid of a clock-work arrangement all one has to do is to keep the machine fed with eggs at one end, and to have a person in attendance to receive the chickens at the other! It need scarcely be added that when the chickens arrive they are immediately transferred to the mechanical mercies of a well-regulated wooden foster-mother.

In Horticulture great advances have also been made, but chiefly by means outside the use of new inventions. The implements used in this pursuit are generally similar in principle, if not in detail, to those used in the older and more extensive art of Agriculture, and in domestic economy generally. Still, the remarkable improvements in lawn mowers, and the extended use of American tools of all kinds, have contributed largely to the recent wonderful increase in the production of fruits, flowers, and vegetables. This development of Horticulture has recently been advocated by many writers and speakers with success; but I must say that it cannot be placed entirely to the credit of the eloquence of the tongues or the pens of these propagandists. The improved and more intelligent use of glass in greenhouses, as in the windows of shops and dwelling-houses, was one of the first results of the repeal of the duty on that material; but it has doubtless necessitated greater skill in devising efficient means of ventilation through a small number of outlets, as compared with what used to take place through the all-pervading cracks of the old-fashioned stoves. The consequent necessity of greater intelligence and ingenuity in the designing and fixing of hot-water apparatus has in itself brought into being a new class of engineers. It is impossible to enter into details of the contrivances that have therefore been devised for ventilation, regulation of heat, shading from sun-light and sun-heat, and many other delicate matters necessary to the successful growth of tropical and sub-tropical plants. But it should be stated that the gardener has been enabled to bring to maturity hot-house fruits, such as pines, in a remarkably short space of time in comparison with what used to be required by the old practices. The invention of "Ward's Cases," and the more recent improvements made in them, have together enabled a large amount of importation and exportation of valuable plants to be carried on. It is not Horticulture alone that has benefited by this means of acclimatization; for, to cite but one instance, to what a great extent are we indebted to "Ward's Cases" for enabling us to cultivate the valuable *Cinchona* in India!

I must conclude this very rapid and brief introduction to the Horticultural portion of Group I. by expressing my cordial thanks to my friends, Dr. Maxwell T. Masters, F.R.S., and Mr. W. Robinson, F.L.S., for the kindness with which they have supplied me with suggestions; and with regard to Arboriculture my thanks are similarly due to Mr. Andrew Taylor, the Editor of 'Forestry.'

The term "Arboriculture," which includes the growth and management of trees for ornament as well as for profit, is much more comprehensive than the term "Forestry," and has been wisely preferred by the Executive Council. Much has been done of late years to improve the management of woods, forests, plantations, and shrubberies of every kind, but little has been done in the invention of mechanical aids to the purpose, except by the Americans, who have produced a variety of ingenious contrivances for pruning, fruit-getting, &c. These have been the more

necessary of late years because the time-honoured advice of the Scotch laird,—“Be aye sticking in a tree,”—has been supplemented by the more modern but equally necessary injunction to “Be aye looking after it.” Forestry has borrowed from farming the system of rotation, and woods and forests are now thinned in a systematic instead of a hap-hazard manner. So we find rotations for thinning, clearing, and replanting extending over intervals which vary from a few years to a century and more.

The means and methods of felling timber-trees by the aid of steam-power, and of transplanting ornamental trees of a large size, have recently been greatly improved, and some of the mechanical aids to these rather difficult operations are highly ingenious. The same may be said of the implements which have been devised for clipping hedges automatically, and some of which do this kind of work in a very satisfactory manner. For the protection of young trees from wild and domesticated vertebrata the skill of the fence-maker has been very usefully obtained; and the efforts of the chemist and the entomologist to assist in minimizing the ravages of insects have been in many cases deservedly successful. In other directions, such as the effect of trees upon climate and the best means of preserving wood from decay, the progress of research has been continuous, if not rapid, but here again the invention of implements and machinery has not been required.

Improvements in roads, permanent and portable railways, ships, and locomotive power have been to the advantage of Arboriculture in common with other productive arts, but nothing can be quoted that is distinctive and peculiar in the means of conveying timber to market, except the American lumber-trains, unless it be the snow on the hills and the water in the rivers. The invention of the Dendrometer has considerably facilitated the estimation of the heights of trees used for masts, spars, and poles; and in the utilization of forest products generally there has been an enormous stride since the introduction of the circular saw, the improvement of the lathe, and the advance in the construction of wood-working machinery. But these subjects lie beyond the scope of “arboriculture,” properly so called.

Within the very circumscribed limits allotted to this preface I have thus endeavoured to invest with something like a living interest the inanimate objects illustrating the progress of invention in relation to the three productive arts which are placed together in Group I.

12 *Hanover Square, W.*, March 16th, 1885.

LAMBETH SANITARY ENGINEERING WORKS.

DOULTON & CO.,

ALBERT EMBANKMENT, LAMBETH, LONDON, S.E.



**THE LAMBETH
PATENT COMBINATION CLOSET.**

COMPRISING

The CLOSET—The SLOP SINK—The URINAL.

AS USED IN THE

Retiring Rooms of the INVENTIONS EXHIBITION.

ADVANTAGES.

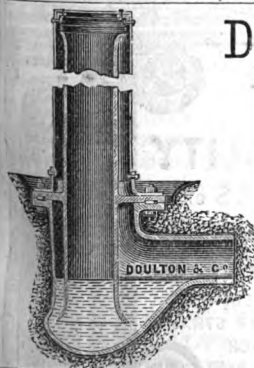
All Parts are open to Inspection—Requires no Enclosure—Is Decorated on the Outside—Front of Basin Lipped to form Urinal when seat is raised— $1\frac{1}{2}$ inches of Water retained in Basin, with a Water Area equal to size of hole in Seat, thus reducing chance of Soiling Basin—May be Flushed by a very simple Seat Action arrangement or by a Pull Handle.

**THE LAMBETH
INSTANTANEOUS WATER BOILER.**

Will Instantaneously heat a Stream of Water to any Temperature up to Boiling.

ADVANTAGES.

Obviates necessity for expensive system of Hot Water Pipes—Is Free from all Injurious Fumes—Has no Visible Condensation—Has no direct contact of the Gas with the Water—Has no Soldered Joints—Water and Gas Supplies are so constructed as to render it impossible to light the Gas without turning on the Water—Is made entirely of Strong Copper.



**Doulton's Improved Automatic
Flushing Syphon.**

Invaluable for keeping Drains and Sewers free from Obstruction.

ADVANTAGES.

Simplicity of Fixing—Freedom from moving Parts—Facility of Inspection—Instantaneous Action, with a Drop by Drop supply.

These Syphons are approved by the LOCAL GOVERNMENT BOARD, and are used by the various Local Boards throughout the Country.

For Further Particulars see List No. 38, Post Free on application.

HOW ROOMS:—ALBERT EMBANKMENT, LAMBETH, S.E.

SHAVING FROM ONE OF HADFIELD'S STEEL CASTINGS 30-FEET LONG.

HADFIELD'S STEEL FOUNDRY CO

HAZLEWOOD CAST STEEL WHEELS, AXLES, ROLLERS & PULLEYS NEARLY TWO MILLIONS IN ACTUAL USE & WORK

RAILWAYS.
ENGINE WHEEL CENTRES,
BOGIE WHEELS & CENTRES,
ROOF STAY BARS, MOTION PLATES,
HORN BLOCKS, AXLE BOXES & SLIDES,
DISTON BLOCKS, CROSSHEADS, POINTS & CROSSINGS,
BUTTER BIKES, TROLLEY WHEELS.

TRAMWAYS.
PATENT
HECLA' WHEELS
(ONE HALF WEIGHT OF CAST IRON)
POINTS
CROSSINGS.
&c &c

COLLIERY AND MINING.
TUB
CORVE & WAGON WHEELS
ROLLERS, PULLEYS,
PEDS, AXLES &c
OVER 2000
DIFFERENT PATTERNS
IN STOCK

ENGINEERS AND GENERAL CASTINGS
OF EVERY DESCRIPTION
TO REPLACE
EXPENSIVE
WROUGHT IRON & STEEL
FORGINGS
AND
HEAVY IRON
CASTINGS

HYDRAULICS.
CYLINDERS FOR ALL KINDS
OF PRESSES UP TO 22¹/₂ LONG
PUMPS, GLANDS,
CROSSBARS
DOORS &c

GEARING
OF ALL CLASSES,
MACHINE MOULDED,
OR FROM FULL PATTERNS
WITH STRAIGHT FACED
OR HELICAL
TEETH

TRADE MARK
OUR SOLE SPECIALITY IS
STEEL CASTINGS
FROM 5 LBS TO 1000 LBS EACH

CONTRACTORS TO
H.M. HOME INDIA & COLONIAL GOVTS

HOME FOREIGN AND COLONIAL RAILWAYS
ADMIRALTY
WAR DEPARTMENTS

AWARDS:
GOLD MEDAL 1873
GOLD MEDAL 1874
GOLD MEDAL 1876
SPECIAL DIPLOMA 1883
HIGHEST AWARD CALCUTTA
HIGHEST AWARD MANCHESTER

MANUFACTURERS ONLY OF THE HIGHEST & BEST QUALITY OF CAST STEEL CASTINGS OF

SPECIAL SOUNDNESS TOUGHNESS & DURABILITY

OUR UNHAMMERED STEEL CASTINGS, AS RECENTLY TESTED BY H-M GOVERNMENT STAND TENSILE STRAINS OF 34 TO 65 TONS PER SQUARE INCH (VARYING ACCORDING TO THE PURPOSE REQUIRED) AND UP TO 20 % ELONGATION.

SHEFFIELD.

UP TO 22 FEET IN LENGTH
HADFIELD'S CAST STEEL
HYDRAULIC PRESS
CYLINDERS FOR
COTTON WOODS
OIL & PRESSES

MACHINE MOULDED
HELICAL

STRAIGHT
UP TO 14 FEET
DIAMETER

GROUP I. — AGRICULTURE, HORTICULTURE AND ARBORICULTURE.

SOUTH COURT.

[For Land Drainage, Reclamation, &c., see Group III.; for Agricultural Engines, see Group IV.; for Manure, see Group XIV.; for Milling Machinery, see Group XVII.]

1. **WALKER, T., & CO.,** Manor House, Whitstable, Kent.—(1) Patent Lubricator for ploughs, &c. (2) Fertiliser for drills.

2. **WORTH, SON, & PONTIFEX,** 379 Oxford Street, London, W.—Patent Safety Box for the carriage of Sheep, Dogs, and Cattle. Model.

3. **DARBY, T. C.,** Pleshey Lodge, Chelmsford, Essex.—Model of a Patent Broadside Steam Digger.

4. **AVELING & PORTER,** Rochester.—Road Locomotive Engine, the side plates of the fire-box are extended upwards and backwards in one piece, so as to provide bearings for the crank-shaft, counter-shaft, and driving-axle. The gearing is all of crucible steel, and mounted on shafts between bearings. The driving-wheels are fitted with compensating motion for turning sharp curves. Patent spring wheels, which possess the advantage of causing the whole weight of the engine to be spring carried.

5. **HORNSBY, R., & SONS,** Limited, Spittlegate Iron Works, Grantham.—(1) The Royal Agricultural Society of England's £100 First Prize Sheaf-binder Harvester, with improved Sheaf-carrier attached. (2) Hercules Mower and Fern Cutter. (3) Indigo Reaper. (4) Colonial Stripper. (5) New Enclosed Gear Grass Mower. (6) Improved Thrashing, Shaking, and Finishing Dressing Machine. (7) Improved Three-Furrow Plough. (8) Improved Gripping Plough.

6. **SAMUELSON & CO.,** Britannia Works, Banbury, Oxfordshire.—(1) Mow Grass Mower. (2) Self-raking Reaping Machine with side delivery. (3) Sheaf-binding Harvester.

7. **NICHOLSON, W. N., & SONS,** Tinsley Iron Works, Newark.—(1) Bone Mill. (2) Hollow Disc Root-Cutter and Pulper. (3) Metal Grinding or Grist Mills. (4) Hay Machines and Horse Hay Rakes.

8. **WOOD, WALTER A.,** 36 Worship Street, London, E.C.—Harvester with automatic sheaf-binder. Grain cut, elevated and delivered.

9. **BARFORD & PERKINS,** Queen Street Iron Works, Peterborough.—(1)

New Pattern Corn-grinding Mills. (2) Model of Self-lifting Steam Cultivator. (3) Model of Three-Furrow Steam Plough. (4) Model of Automatic Anchor for steam cultivation.

10. **RICHES & WATTS,** Duke's Palace Iron Works, Norwich.—(1) Riches' Patent Revolving Rake. (2) Riches & Watts' Patent Eureka Grist Mill.

12. **CORBETT, T.,** Perseverance Iron Works, Shrewsbury.—(1) Excelsior Single Furrow Plough. (2) Uniform Ridging and Moulding Plough. (3) Colonial Line Harrows, with folding arrangement for export. (4) Combination of Winnow, Corn Elevator and Weighing Machines. (5) New Patent Eclipse Grain, Seed, Tea, Coffee and Rice Dressing and Cleaning Machine, with elevator attached. (6) New Pattern Duro Chaff-Cutter for power, with recent improvements. (7) Cheese Presses, single and double chamber with compound levers, and fitted with various improvements. (8) Improved Oil and Cotton Cake Breaker.

13. **JOHNSTON HARVESTER CO. (THE),** 70 & 71 Chiswell Street, London, E.C.—Mowing, Reaping, and Sheaf-binding Reaper Machines.

14. **MCCORMICK HARVESTING MACHINE CO.,** Chicago, Illinois, U.S.A.; and 44 Summer Street, Southwark, London, S.E.—Sheaf-binding Reapers.

15. **HARRISON, MCGREGOR, & CO.,** Albion Iron Works, Leigh, Lancashire.—(1) Mowing and Reaping Machines. (2) Chaff and Turnip Cutters.

16. **BAMFORD, HENRY, & SONS,** Leighton Iron Works, Uttoxeter.—(1) Patent Progress Haymaker, with new corrugated screen. (2) Patent Royal No. 2 Mower, with extra high wheels, all gearing under one cover, and improved tipping lever for cutting laid grass. (3) Patent One-Horse Mower. (4) Patent Self-acting Horse Rake.

17. **RANSOMES, SIMS, & JEFFRIES,** Limited, Orwell Works, Ipswich.—(1) Patent Furnace and Apparatus for burning straw, cotton, and maize stalks, seeds, rice, husks, and other vegetable substances as well as coal and wood, adapted to a portable steam engine. (2) Patent Apparatus for chopping, bruising, and softening the straw for hot countries, adapted to a steam thrashing machine. (3) Jefferies' Patent Lifting Apparatus adapted to two and three furrow ploughs.

18. **GARRETT, RICHARD, & SONS,** Leiston Works, Leiston, Suffolk.—(1) Portable or Semi-portable Compound Engine and Boiler. (2) Fire-Box, with corrugated crown. (3) Manhole Ring and Steam Dome. (4) Wrought-iron Travelling Wheel with wooden lining to tire. (5) Garrett-Ellis' Patent Drum, with rolled steel reversible

beaters. (6) Lever Horse Hoe. (7) Corn and Seed Drill. (8) Sand and Salt Distributor for roads and tramways. (9) Lakeman's Circular Saw Guard.

20. **LANDER, HENRY**, Shaftesbury Road, Mere, Wilts.—(1) Improvements in Movable Roofs, for use as hay and corn shelters, with Ventilation combined. (2) Hay Collector, with Haymaker combined.

21. **WILKINSON, WILLIAM**, Kempston, Bedfordshire.—Improved Disc and Hoes for turnip-thinning machines.

22. **HOWARD, J. & F.**, Britannia Iron Works, Bedford.—(1) Sheaf Binder. This machine is adapted to cut and bind into sheaves all kinds of grain crops. It is also fitted with a sheaf collector, by means of which the sheaves may be laid in rows for being set up in shocks. (2) Machine for trussing and bundling straw, combined with the ordinary thrashing machine. (3) Models of Agricultural Implements, &c.

23. **PORRITT, J. W.**, Cley, Dereham, Norfolk.—Patent Sack Hoist, for the application of horse power.

24. **JEFFERY & BLACKSTONE**, Rutland Iron Works, Stamford.—(1) Chaff-Cutter. (2) Grist Mill, fitted with stones running vertically, and Patent Brush Arrangement. (3) Haymaker, with new Patent Spiral Fork Bars. (4) New Stamford Semi-Automatic Horse Rake.

25. **SAINTY, J.**, Commercial Road, East Dereham.—Oat Separators.

26. **CROWLEY, J., & CO.**, Meadow Hall Iron Works, near Sheffield.—S. Edward's Patent Safety Lever Ensilage Cutter and Elevator, fitted with new patent duplex safety lever for stopping, reversing and varying the length of cut; also an adjustable mouth with safety roller to prevent any accident occurring to the feeder.

27. **RICHMOND & CHANDLER**, Southall Street, Manchester.—(1) Chaff-Cutters. (2) Corn Crushing Mills. (3) Root Cutters. (4) Root Pulper. (5) Horse Gear Works. (6) Root Washers. (7) Improved Steaming Apparatus for cooking food for cattle, &c.

28. **VIPAN & HEADLY**, Church Gate Agricultural Implement Works, Leicester.—(1) Steel Railway Cans. (2) Hand Milk Trucks. (3) Cheese Press. (4) Refrigerator. (5) Cream Cans and Bottles. (6) Counter Pans, Show Cans and other Dairy Appliances.

29. **BARHAM, G.**, 25 Hart Street, London, W.C.—Complete Collection of Apparatus for analysing and testing the quality of milk and dairy produce, including all the most recent inventions and improvements.

30. **MAUDE, J.**, Westvale, near

Halifax.—Improved Machinery for making butter.

32. **AYLESBURY DAIRY CO., Limited**, 31 St. Petersburg Place, Bayswater, London, W.—(1) The Danish Cream Separator, for extracting cream from milk by centrifugal force. (2) Apparatus for use with the above separator, for the emulsion of two substances of dissimilar specific gravity.

33. **NEIGHBOUR, GEO., & SONS**, 127 High Holborn, W.C.; and 149 Regent Street, London, W.—(1) Improvements in Movable Comb Bee Hives and Section Honey Boxes, with arrangements for artificial comb guides to assist the bees in the building of comb and better storing of honey. (2) Appliances for the use of Apiarians, such as honey extractors, smokers, feeders, machines for making wax foundations, bee reils, gloves, knives for uncapping combs, &c.

34. **BALDWIN, S. J.**, The Apiary, Bromley, Kent.—(1) Improved Hives. (2) Honey and Wax Extractors. (3) Protectors from Stings. (4) Bee Quietors, Cages, &c. (5) Honey and Apparatus for safe conveyance. (6) Machines for making comb foundation [will be at work on certain days]. (7) Wax and Honey in applied forms.

35. **STROUD, R., & CO.**, Nippon Works, Wolverhampton.—Improvements in the manufacture of necks for cans or churns for the transport of milk, &c. All seamless, and produced from highly finished steel.

36. **LANCELAND, WOOD, & CO.**, The Avenue, Acton, Middlesex.—Wringlocks, Incubating Ovens, Chicken Brooders, &c.

37. **UNITE, JOHN**, 291 & 293 Edgware Road, London, W.—(1) Improved Dressed Tarpaulins. (2) Van and Carriage Covers. (3) Aprons. (4) Horse Clothing. (5) Sail Canvas. (6) Cordage and Blocks. (7) Outdoor Games. (8) Waterproof Clothing. (9) Models of Rick Cloth. (10) Square Garden Tent. (11) Hospital and Military Officers' Tent. (12) Temporary Theatrical Stage. (13) Temporary Pavilion.

38. **REYNOLDS, F. W., & CO.**, Acorn Works, Edward Street, Blackfriars Road, London, S.E.—(1) Patent Portable Silo. (2) Patent Mechanical Pressure for Silage erected in above, but suitable for any kind of silo. (3) Models of Silos fitted with Reynolds's Patent Mechanical Pressure. (4) Model showing Reynolds's Patent Mechanical Pressure as applied to silage made in open stacks or to hay-stacks. (5) Model of Iron and Concrete Portable Silo.

39. **MAUDE, J.**, Westvale, near Halifax.—Improvements in Silos and Apparatus for imparting pressure.

40. **JOHNSON, C. G.**, Oakwood, Croft, Darlington.—Two Models of Patent Ensilage Stack Press, representing a stack con-

taining 150 tons of ensilage. [Scale 1 in. = 1 foot.]

41. **EDWARDS, G. M., 54 Gresham Street, London, E.C.**—Dovetailed Corrugated Iron Sheet Cylinders for use as silos.

42. **ENSILAGE PRESS CO., Leicester.**—Blunt's Patent Screw and Lever Silo Press, adapted for every description of silo or ensilage stack.

43. **FLETCHER, J. M., Cheadle, Cheshire.**—Labour-saving Movable Silo, with the Cheshire screw and chain pressure apparatus complete, and guide rings in wall for the pressure chains to run through, which prevent strain on the walls from the bulging of the pressed ensilage.

44. **GOODRIDGE, H., 23 Langton Street, Chelsea, London, S.W.**—The Self-locking Apparatus for railway facing points and signals.

45. **ROBERTS, CHAS. F., Linlith, Delph, near Oldham.**—Model of Silo, showing an improved method of applying pressure to contents without weights.

46. **HILL, E. J., 6 Westminster Chambers, Victoria Street, S.W.**—Railway Carriage Door and Window.

47. **DIMES, W. P., Oldstone, Blackawton, Devon.**—Improvements in gates.

48. **CLARK & MOSCROP, Darlington.**—Design for a Model Dairy Homestead, suitable for a farm of 180 acres, 165 acres of meadow and pasture, and 15 acres of arable land. Accommodation for ninety-three head of cattle, five horses, besides pigs and poultry.

49. **WORMALD, W. G., 163 Fentiman's Road, South Lambeth, London, S.W.**—Plans and Designs for farmhouse.

50. **WRIGHT, RICHARD, High Lodge, Richmond, Yorkshire.**—(1) Seythe, with safety scabbard or sheath. (2) Model of a Safety Railway Door, preventing fingers getting smashed.

52. **LLOYD, LAWRENCE, & CO., 34 Worship Street, London, E.C.**—Lawn Mower.

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54. **PREIST & CO., 314 Oxford Street, London, W.**—Pruning Knives and Garden Tools.

55. **ROSEHER, F., Old Jamaica Wharf, Blackfriars, London, S.E.**—Improved Fumigator for greenhouses.

56. **DE LATASTE, EDWARD, Woodford, St. Brelade's, Jersey.**—Improved Vine Rod Fastener.

57. **BENNETT, W. E., Condover, near Shrewsbury.**—Improvements in se-

curing rose, fruit, conifers, and other trees to their stakes and supports in upright positions, without damage to the tree.

58. **BULL, WILLIAM, 536 King's Road, Chelsea, London, S.W.**—Improved Case for exporting and importing plants.

60. **BETHELL, T. P., 24 Cable Street, Liverpool.**—Improvements in Boxes for postal, packing and storing purposes, for the transit of cut flowers, fruit, game, bottles, fragile articles, &c.

61. **PAGE, HENRY, & SONS, Grove Nursery, Teddington, London, S.W.**—Patent Simplex Holdfast Iron Post or Column.

62. **JOHNSON, RICHARD, & NEPHEW, Bradford Iron Works, Manchester; and 8 Great Winchester Street, London, E.C.**—Barbed Wire for fencing.

64. **WILLS & SEGAR, Royal Exotic Nursery, Onslow Crescent, London, S.W.**—Wills's Patent Illuminated Water-wheel and Revolving Light Machinery for lighting grottos, aquariums, ferneries, rockeries, fountains, cascades, waterfalls, and all kinds of floricultural and horticultural buildings.

65. **WHITEHOUSE, CORNELIUS, Cannock Edge Tool Works, Cannock, Staffordshire.**—Brushing Bills and Slashers.

66. **SMITH, JOHN, Royal Label Factory, Stratford-on-Avon.**—Horticultural and other Labels.

67. **BAGLAN, WILLIAM, 15 Mornington Road, New Cross, London, S.E.**—Patent Galvanised Pit Light-lined with felt, showing new method of glazing air-tight and frost-resisting.

68. **SPENCER, CHARLES, 1 Mornington Road, Deptford.**—Revolving or Sliding Roof for greenhouses, &c.

69. **DAVIS, JOSEPH, & CO., Fitzroy Works, Kennington Park Road, London, S.E.**—Dendrometers and other Instruments, including Milk and other Testing Apparatus.

70. **MACKENZIE, D. F., Morton Hall, Midlothian, N.B.**—(1) Dendrometer and Distance Finder combined. (2) Dendrometer and Level combined.

72. **ROOM, J., Kingsweston, near Bristol.**—Patent Pruner.

73. **ROWLATT, JOHN, 37 Welling-ton Street, Leicester.**—(1) Machine for peeling osiers. (2) The Climax Fastening, for securely fastening hampers and sample cases.

80. **DEACON, GEORGE, 103 Lower Thrift Street, Northampton.**—An Improved Method of Glazing without putty for horticultural buildings, railways, roofs, &c. (See Outside, South Promenade.)

81. SHEA, C. E., The Elms, Fots Cray, Kent.—Improved Horticultural Frames and Lights. (*See Outside, South Promenade.*)

82. KENNEDY, WILLIAM, 70 Robertson Street, Glasgow.—Translucent Plates or Sheets for use as substitutes for glass in roof-lights, suitable also for various ornamental purposes, such as painted window screens, &c. (*See Outside, South Promenade.*)

83. SARGENT, GEORGE, Ditton, Maidstone.—Patent Continuous Fencing. (*See Outside, South Promenade.*)

87. SKINNER & BOARD, Horticultural Works, Stokes Croft, Bristol.—Patent Venetian Fruit and Flower Houses. (*See Outside, South Promenade.*)

88. MONRO, JOHN, New Barnet, Herts.—Glass Shelter Wall or Fence, convertible into pit or spawn-house, for getting the full advantage of the sun in ripening fruit-vines, espaliers, tomatoes, &c., in the open; for protection from wind, frost, hail, and sea spray; and for the earlier and better production of all kinds of vegetables, flowers and seeds. (*See Outside, South Promenade.*)

90. RENDLE, W. E., & CO., 3 Westminster Chambers, London, S.W.—Original System of Glazing without putty. (*See Outside, South Promenade.*)

92. STEVENS, ROBERT, Horticultural Builder, Bromley, Kent.—Patent three-bar system of glazing. (*See Outside, South Promenade.*)

95. DASHWOOD, A., & CO., 28 & 29 St. Swithin's Lane, London, E.C.—Conservatory erected on their combination principle, the upper portion showing the adaptability of the shutter-bar system for large roofs, also a Greenhouse erected on their shutter-bar system of glazing. (*See Outside, South Promenade.*)

96. BARFORD & PERKINS, Queen Street Iron Works, Peterborough.—Water Ballast Rollers for gardens, asphaltting, tennis and cricket grounds, field and estate purposes, and for road making. (*See Outside, South Promenade.*)

97. DEARDS, S., Horticultural Buildings, High Street, Harlow, Essex.—(1) The Patent Victoria Dry Glazing:—One Large Conservatory; One Villa Conservatory; also Specimen of Victoria Dry Glazing, specially adapted for factories, shops, warehouses, &c., 50,000 feet of which have been used on the roofs of the International Invention Exhibition Buildings. (2) Patent Close Coil Boilers, to heat from 200 to 1500 feet 4-in. pipe. (3) Patent Independent Coil Boilers. (4) The Princess Louise Coil Grate, specially made to heat conservatories from the ordinary fire-place. (*See Outside, South Promenade.*)

98. PINCHIN, JAMES, Hill View House, Market Lavington, Devizes.—

(1) Model of New Indestructible Exceller and Challenge Glass and Iron Roof Coverings. (2) Improved Greenhouse, &c. (*See Outside, South Promenade.*)

99. FOSTER & PEARSON, Beeston, near Nottingham.—(1) Hot Water Horizontal Tubular Boiler to heat 2000 feet 4-in. pipe. Amateur's Boiler. Valves. (2) Span-roofed Movable Frames. (3) Cucumber Frame. (4) Plant House. (5) Curvilinear-roofed Conservatory. (*See Outside, South Promenade.*)

100. MALET, O. W., Courtfield Gardens, South Kensington, London, S.W. (Agents, **THE GLOBE ELECTRICAL AND ENGINEERING CO.,** 20 Dartmouth Street, Westminster, London, S.W.)—F. Malet's Patent Solid Barbed Wire Fencing for Colonial use. (*See Outside, South Promenade.*)

BRINDLEY, J., & CO., Limited, 67 King William Street, London, E.C.—Slate Silo. (*See Outside, South Promenade.*)

BRITISH PATENT GLAZING CO. (THE), 24 Finsbury Circus, London, E.C.—Improvements in and relating to the glazing of roofs and other structures. (*See Outside, South Promenade.*)

ANDERSON, R. F., C.E., 84 Commercial Street, Dundee. (*See Group X.*)

AVERY, W. & T., Digbeth, Birmingham; and 14, 15 & 16 Cow Cross Street, London, E.C. (*See Group XI, Queen's Gate Annex.*)

BAXTER, CAPT. J. C., R.E., Colchester, Essex. (*See Group XXV.*)

BECK & CO., Limited, 130 Great Suffolk Street, Southwark, London, S.E. (*See Group IV.*)

BARRETT, H. J., 17 High Street, Hull (Agent, **J. HUMPHREYS,** 10 Leadenhall Street, London, E.C.). (*See Group VI.*)

BRITISH PATENT GLAZING CO. (THE), 24 Finsbury Circus, London, E.C. (*See Outside, South Promenade.*)

BROADBENT, ROBT., & SON, Phoenix Iron Works, Stalybridge, Cheshire. (*See Group X.*)

BROWN, J. D., & CO., 49 Fenchurch Street, London, E.C. (*See Group III.*)

BURT, BOULTON, & HAYWOOD, 64 Cannon Street, London, E.C. (*See Group XIV.*)

CARTER, J. HARRISON, 82 Mark Lane, London, E.C. (*See Group XVII.*)

CROFT STONE QUARRY & BRICK CO. (THE), Croft, near Leicester. (*See Group III.*)

CROSSLEY, C. W., 14 St. Mary Axe, London, E.C. (*See Group II.*)

FOULIS, JOHN, 28 Market Place, Musselburgh, Midlothian, N.B. (*See Group XI.*)

GARDNER, A., & SON, 36 Jamaica Street, Glasgow. (*See Group VII.*)

GREEN, G. F., & CO., 3 George Yard, Lombard Street, London, E.C. (*See Group XXVI.*)

GREIG, J., & CO., Regent Works, Regent Road, Edinburgh. (*See Group XVII.*)

HARDY PATENT PICK CO., Limited, Sheffield. (*See Group II.*)

HEARSON, CHARLES, & CO., Limited, 235 Regent Street, London, W. (*See Group XV.*)

HEDICKE, M., & CO., 3 Adelaide Place, London Bridge, London, E.C. (*See Group XVII.*)

JACKSON, J., 8 Frederick Place, Gray's Inn Road, London, W.C. (*See Group IV.*)

KERR, STUART, & CO., 20 Buckersbury, London, E.C. (*See Outside, South Promenade.*)

MARSDEN, H. R., Leeds. (*See Group X.*)

MITTON, PAUL, 69 Oxford Street, London, W. (*See Group VI.*)

MORTON, WILLIAM CHARLES, Longfield Villa, Coleshill, Birmingham. (*See Group IV.*)

NICHOLSON, W. N., & SON, Trent Iron Works, Newark. (*See Group IV.*)

RICHTER PATENT ECONOMISER MANUFACTURING CO. (THE), West End Mills, Longside Lane, Bradford. (*See Group IV.*)

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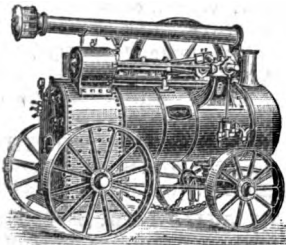
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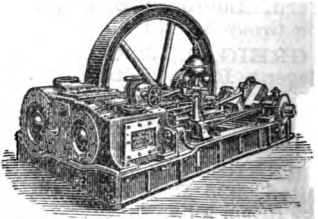
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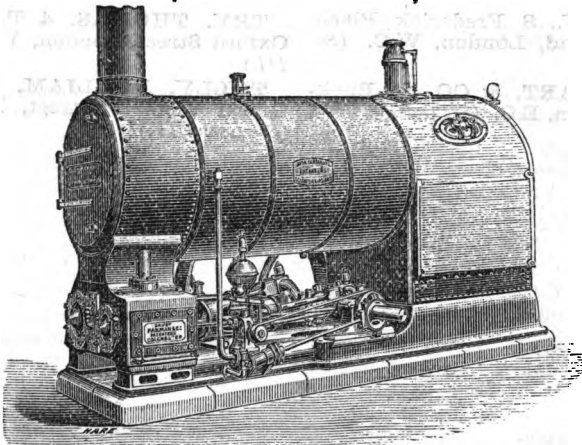
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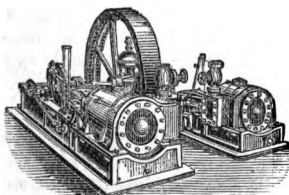
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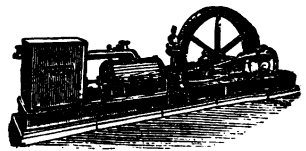
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MINING AND METALLURGY.

By H. BAUERMANN, F.C.S.

THE progress of invention in mining and metallurgy during the past twenty-five years may in great part be considered as synonymous with that in general mechanical engineering, machinery of increased power and greater precision having been called for by the enlarged scale upon which mining and smelting operations are now conducted, while the discovery of new mineral districts has led to the invention of new methods of working or such considerable modifications of older methods, as to bring them substantially into the category of new ones. The very comprehensive character of the headings of the different classes render it impossible to furnish anything like even a catalogue of the names of inventors whose work has extended over the period under review, and all that will be attempted is a very brief outline of the more striking results obtained.

In MINING, the advance in methods of deep boring, whether for exploratory purposes, or in the actual winning of minerals, such as salt, mineral oils, and combustible gas, has been very marked. This is to be attributed mainly to the adoption of steam instead of manual power, and of the method of continuous flushing by the substitution of hollow rods, with a circulation of water for the removal of the detritus produced by the cutting tool, for the solid rods and sludge-pump of the older intermittent methods. This improvement, originally adopted by Fauvelle in France, has come into very general use in America, where it has attained a high degree of development in the oil regions of the Northern United States and Canada. Another and more important improvement, however, is the adoption of annular or core-boring methods, whereby the central portion of the ground bored through is left standing, and may be brought up in lengths from time to time. This may be used in combination either with percussive or rotating cutters, one of the most important forms of the latter being the Diamond boring machine, in which fragments of hard uncleavable diamond, or *carbonado*, bedded in a steel ring, are used instead of steel cutting tools. This method, originally due to Leschot of Geneva, has been largely used in England, the United States, and the Colonies, and to a lesser extent in Europe. Nearly all the remarkable discoveries of the subterranean extension of the older formations under London and in different parts of the south of England, have been made by the Diamond boring machine. Boring machines of large size have also been applied to the special purpose of sinking shafts through very watery ground where it is not possible to keep the bottom sufficiently dry for sinkers to work in the bottom. This has been especially developed in Belgium by Kind and Chaudron, and one of the latest applications has been in the sinking of a pair of large pits at Marsden in Durham.

The most important and characteristic operation of mining proper, that of breaking ground, has been completely modified in late years by two principal causes, namely, the introduction of boring or drilling machines as substitutes for the older method of hand boring, and of more powerful kinds of explosives for the blasting powder, which had been in use substantially without improvement since its first introduction in the 16th century. Of these latter substances the choice now offered to the miner is almost embarrassingly large, but prominent among them are those depending upon the nitro-compounds, nitro-glycerine and nitro-cellulose. The most popular of all is the so-called dynamite of Nobel, a plastic mass formed by soaking infusorial silica with nitro-glycerine, which is now used in every mining district in the world; besides which, Abel's compressed gun-cotton, and the material known as blasting gelatine, a kind of gun-cotton dynamite, are also largely employed; and in spite of the special dangers attending their use, there can be no doubt that the miner has substantially benefited by the introduction of these so-called *high explosives*.

The use of boring machines, though less general than that of the newer explosives, has led to a considerable development of this class of mechanism. In the earlier forms, as used in large works such as the great Alpine tunnels, where rapidity in work was a principal desideratum, they

were rather heavy, especially in the supporting arrangements which were generally planned for keeping two or more machines at work at one time; but the requirements of smaller and irregular excavations, such as the levels and stopes of metallic mines, have led to the adoption of lighter and more portable forms which have done much towards popularising their use in mines. The number of different kinds of machines in current use is very large, at least twenty-five patterns having been introduced since 1863. The working principle is common to all, namely, a steel drill or borer attached to the rod of a piston which is rapidly driven against the rock by steam or compressed air, the latter being most generally used in confined or underground spaces; the borer in addition to the reciprocating motion being slowly rotated about its axis. The differences in construction are chiefly to the mode of effecting this rotation and that of moving the valve. In some the construction is simplified by dispensing with the use of movable valves, the distribution being effected by the piston itself.

In addition to the percussive borer others with a continuous rotatory action have been introduced. These are mostly adapted for manual power and for use in soft rocks, such as coal and salt. The cutting tool is made self-clearing by adopting a spiral form or that of the ordinary twist drill. The machines of Lisbeth and Macdermott are of this type. On a larger scale where power is applied the rotatory system is represented by the Diamond drill already noticed, which is susceptible of application in almost any position, and the hydraulic borer of Brandt, in which the cutting is effected by a strong tubular saw, rotating slowly while under a heavy pressure produced by a column of water (1500-2000 lb. per sq. inch), as contrasted with the more rapidly revolving Diamond cutter. This has been used in the Airlberg tunnel and in the deep mines of Pfibram.

The use of machinery in another characteristic part of mining labour, namely, the holing or under-cutting of coal, has been introduced during the period under review. Of these the earlier forms reproduce the action of the miner's pick, the tool being moved on a horizontal plane by a piston and bell-crank. Firth's machine is of this kind. In others, such as that of Carrett, Marshall & Co., the tool is similar to that of a slotting machine, while in that of Winstanley and Barker and Baird, rotating cutters mounted on a wheel or flexible chain are used. It is somewhat remarkable that, in spite of the many advantages to be derived from their use, coal-cutting machines have as yet made but little progress towards general adoption.

In another direction the danger of using explosives in fiery mines has been met by several inventions, such as the compressed lime cartridge of Smith & Moore, where the disruptive force necessary to break down coal is supplied by the expansion of compressed quicklime by hydration under pressure. This is used currently in Derbyshire. Other machines depend upon the use of expanding bits by wedges driven by hydraulic pressure, as in those of Jones & Bidder and Levett. The latter method has also been applied on the largest scale in driving galleries in the Bosseyeuse of Dubois & François. This is a boring machine of large size capable of drilling 4-inch bore holes for plug and feather wedges, which are driven home by a heavy mallet, that is substituted for the drill when breaking down the hole. In the Marihay collieries in Belgium, producing over 400,000 tons of coal annually, machinery has been entirely substituted for explosives in getting coal for some years.

In the working of mines few modifications of importance have been made of late. The tendency, generally speaking, is towards methods allowing a continuous excavation of the mineral, such as long wall work, rather than those involving the retention of large areas of pillars. In thick and highly inclined coal seams the method of removal of the bed by horizontal slices, and filling the excavation with stuff, either broken from the adjacent rock or brought from the surface, is now commonly used. In some instances blast furnace slags have been used as filling material.

The use of timber for securing underground workings is still general, though in many European districts it is becoming scarce and dear. As a substitute wrought-iron frames made of rails or bars of similar section, bent to the contour of the level and put together with fish plates, have been adopted to some extent in collieries, as have also wrought-iron rings in circular shafts, instead of timber or masonry. The heavy pit head and shear frames of large collieries are now very often made of wrought iron or steel put together in a lattice or tubular form. In the Kind-Chandron system of boring shafts through wet ground, the use of cast-iron tubbing is an essential. This, however, is made in rings cast of the full size section of the shaft instead of being put together in segments like the earlier metal tubbing of the north of England.

In the transport of minerals underground the distance of the workings from the pit bottom, due to the large areas of ground worked from a single pair of pits, renders mechanical traction necessary in many cases. This is effected in very many ways; steam hauling engines, placed near the pit bottom, or compressed air-engines, and working a line of wire ropes along the main roads, being the most popular. Sometimes the hauling rope is brought from an engine at the surface, and carried over reversing pulleys on the shaft to avoid the use of underground engines. Special methods, involving the use of locomotives, have also been devised, the most notable of which is the electric railway of the late Sir W. Siemens, adopted at Zaukeroda and in Silesia. Fireless locomotives, driven by compressed air or steam from super-heated water and caustic soda lye, have also been introduced, but none of these have advanced much beyond the experimental stage.

Although numerous modifications have been made in the arrangements for drawing minerals in shafts, they are mainly improvements of older methods, rather than the introduction of new ones. In order to reduce the ratio of dead to paying load, steel has been largely substituted for iron in the construction of pit trams and cages, while the latter have been increased in capacity so as to carry six or eight trams at one time. Wire ropes of tapered section, made of steel of as high a tensile strength as is consistent with flexibility, are now commonly used, although in Belgium also fibre ropes still maintain a high reputation. In deep shafts the question of counter-acting the variation in the load on the engines, due to the constant change on the relative position of the ascending or descending cages, is of great importance, and several methods have been adopted, one of the best being the spiral or scroll drum where the rope coils upon a bed of gradually increasing diameter as the cage ascends, while the descending load uncoils from a diminishing spiral; but the great size and weight of such drums is rather against their use. Another method, by an auxiliary balance chain hanging in a special pit, is frequently used in mines of moderate depths. In Koepe's system a constant load is obtained by dispensing with the use of drums, the two cages being connected by a rope passing over a grooved pulley on the main driving shaft at the top, and by a tail rope hanging on a loop below them, so that wherever the cages may be the weight on the engine is unchanged. Blanchet has still further simplified drawing by dispensing with ropes, the cage being placed between two pistons, which are propelled through a vertical tube by the pressure of the atmosphere against a vacuum produced by an exhausting pump at the surface. This has been successfully applied to a pit nearly 2000 feet deep at Epinac in France, but the great cost has militated against it being generally used. The practice of American mining engineers in regard to winding engines is in strong contrast to those of Europe; geared engines with fast and loose couplings, usually of a frictional character, being very common; steam being used only for hauling while the descending load runs off by its own weight under the control of a brake. This allows the winding arrangements of a large mine, drawing from numerous points, to be concentrated in a single engine-house.

With a view to the prevention of accidents by overwinding, and the breaking of pit ropes, safety hooks, for disconnecting the cage from the rope and safety catches for stopping a free falling cage in its descent, by gripping or cutting into the pit-guides, have been introduced at different times in many different forms (some of these were constructed before 1851), and are largely, though by no means universally, employed; for although their utility has been proved in many cases, they are not so perfectly certain in action as to be always reliable. As important accessory appliances towards safety in winding may be mentioned steam brakes and reversing gear on the engines, and improved pit signals, for which latter purpose electric telegraphs are taking the place of the old knocker lines.

In the drainage of mines the general tendency is to the substitution of direct double-acting short stroke engines placed underground for the older form of single acting beam engines at the surface, which does away with the use of heavy wooden rods in the shaft. It is also becoming common to substitute solid or built-up rods of wrought iron for those of wood where surface engines are used. Hydraulic and pneumatic accumulators, which store up the superfluous momentum of descending pump rods and utilise it on the return stroke, have also, in some cases, replaced the older kinds of balance weights and bobs. Among the more important contrivances for ensuring safety in pumping machinery are Davey's automatic regulator for non-rotary engines, and Kley's adaptation of the cataract to those with fly-wheels.

In the ventilation of mines the use of large exhausting fans has in many cases superseded

the underground furnace, and of the different patterns that of Guibal, with straight blades enclosed in a spiral casing with a tapered discharging chimney, is by far the most common. Latterly, however, the method of blowing fresh air through the workings by a compressing fan at the bottom has met with some favour, as has also that of distributing air at high pressure through pipes to different workings, which can be then utilised either directly or preferably in driving special ventilating machines, such as Körting aspirators or small fans, so as to produce local ventilating currents where required. The problem of producing lamps that shall be safe under all circumstances in fiery mines is still unsolved, although much ingenuity has been devoted to it as well as to the accessory detail of an inviolable method of fastening them. The general opinion seems to be that the Muscler construction is about the safest now in use.

Important aids to life-saving service after accidents has been afforded by the apparatus of Denayrouze and Fleuss, where, by the use of compressed air or oxygen and lime-water or caustic soda for absorption of the carbonic acid produced in respiration, a miner with a lighted lamp may remain in workings entirely without respirable air for as much as an hour at a time.

In the various operations required for rendering the produce of mines merchantable there is little that is actually new in principle, the advance made in the dressing of minerals on the large scale required by modern mining economics being mainly in the direction of systematic arrangement of the different processes, and more particularly in the more exact sizing of materials as a preliminary to separation processes proper. In the preliminary breaking down of large fragments of rock to more manageable sizes, the Blake rock breaker, whose invention by the late Mr. Blake, of Newhaven, Connecticut, was nearly coincident with the commencement of the period under review, has come into almost universal use, and generally in the original form, although some special modifications have been made to render it available for breaking to finer sizes. The work of breaking to coarse sand or gravel sizes is performed almost exclusively by the Cornish roller crusher, which has, however, been subjected to considerable modification both as regards size of rolls, which are now very much larger than formerly, and in the arrangements for preventing breakage by the substitution of springs of steel, india-rubber, or both combined, for the weights acting on unequal armed levers originally used. For finer pulverizing down to the grain of fine sands without preliminary reduction the old gravitating stamps with square heads and lifted by cams are still of the greatest importance, although in America and Australia, where the accessory work of amalgamating as well as pulverising is done on the battery, cylindrical stamps, which are rotated as well as lifted by cams, are used to the exclusion of the older European form. Attempts have been made to increase the working speed and force of impact of stamps by the substitution of fluid pressure for simple gravitating action. Of these two forms may be particularly mentioned, namely Husband's pneumatic stamps with a flying compressor on the stamp lifter producing a supply of air at high pressure, which is exhausted and renewed at each blow of the head, and Ball's steam stamp, which is essentially a directly acting steam hammer with an auxiliary gear for turning the tup and rod about its axis. The pneumatic stamp has been successfully employed in a few places, while that of Ball is largely used in the Lake Superior copper mines, where the ore is entirely native copper, but has not been adopted outside of that district.

In the treatment of ores very finely interspersed in the waste rock, it becomes necessary to grind them to a finer powder than can be obtained with stamps, in machines of which the ordinary edge runners or drag mills are types. These are represented in new forms by Dingey's pulveriser used in grinding fine sands from tin and silver-lead ores, and the various forms of pans used in the American processes of amalgamation, which are improved reproductions in iron of the old Mexican arrastra. Various forms of centrifugal pulverisers have been introduced from time to time in which grinding takes place by the mutual attrition of suspended particles, or by impact with steel blocks or bars. These may be represented by Carr's Disintegrator, a system of concentric cages of bars revolving rapidly in opposite directions, and Vapart's "Broyeur," which is a series of horizontal discs with radial projecting ribs placed one above another. The use of this class of machine is practically limited to soft materials.

In sizing machines notable advances have been made by the adoption of perforated plates instead of wire network for the sifting surfaces of drum sieves, which not only resist wear better, but give more uniformly sized products, while for finer materials diffused through water, various systems of current sizers have been developed from that devised about thirty years since by the late Ritter von Rittinger.

The method of separating minerals by the pulsating action of a column of water forced through a sieve plate from below in the so-called jiggling process has been greatly extended in application, owing to the numerous modifications in construction which have transformed the original plunger jigger of Petherick and its immediate successor, the square plunger Harz jigger into a series of machines adapted alike for mineral and coal dressing, and for materials varying in size from the coarsest gravel to very fine sand. It would, however, require too much space to enter further upon the consideration of these. In the treatment of very finely divided ores or "slimes" rotating conical frames, both of convex and concave form, are to a great extent replacing the older kinds of fixed plane and conical buddles, while on the continent of Europe the side-blow percussion table of Rittinger is in considerable favour. In America the Frue vanner, a combination of a travelling belt (derived from the original Brunton frame) with the side-blow action of Rittinger, is in great repute as a concentrator of fine slimes, and has been subjected to numerous modifications by other constructors.

Before leaving the subject of dressing it may be interesting to notice that the practice of engineers tends to the substitution of rolls for stamps even in the reduction of minerals, such as gold and silver ores, for which the latter were formerly considered essential. This change of practice seems to be well founded, as it is in accordance with the experience gained in the case of flour milling.

METALLURGY.

The changes that have been effected in iron and steel manufacture since 1862 by the introduction of new and the modification of old processes, have been so great that it will be impossible to notice them here otherwise than on the broadest general outline. In the fundamental operation of smelting pig-iron from the ore which forms the starting point of the larger and more important methods of steel and malleable iron making, there is a general tendency in modern blast furnace practice towards the adoption of furnaces of the dimensions and types of construction that have been developed by the metallurgists of the Cleveland district, i.e. with steep conical bushes and stacks, and broad hearths and throats, with a maximum breadth of about 20-22 feet, and 75-85 feet in height. At one time higher furnaces were tried but failed to prove practically useful, and the above sizes have been shown to be in accordance with theoretical possibilities by the valuable experimental researches of J. L. Bell and P. von Tunner who, by determining the limits of reducing activity in the furnace gases have furnished a useful test of the working condition of furnaces. The productive capacity of furnaces, owing to the use of increased blowing power and more highly heated blast, has been most enormously augmented. In 1862 about 200 tons a week was a high yield, while at present, furnaces running 70-100 tons daily are common, and in America even 200 tons a day has been exceeded. In blowing engines the old ponderous low-pressure condensing beam engines have been superseded by light short-stroke patterns running at high speeds, the change being exactly similar to that which has replaced the side lever marine engine by the inverted "forge hammer" pattern; while for blast-heating, gas firing have become almost universal, and the numerous complicated forms of iron pipe stoves have been replaced by simpler forms, of which that by Mr. Gjers may be taken as representative. Of more importance are the brick stoves for superheated blast upon the regenerative principle of Sir W. Siemens, of which two forms, those of Cowper and Whitwell, are largely used, being about equally popular. Another modification that has become almost universal is the suppression of the open tymp arch, the furnace being entirely closed with the exception of a small passage for the slags in a water-cooled casting, known as Lürmann's slag twyer. The use of special water-cooled surfaces as a means of counteracting the corrosive action of the slags in the more highly heated parts of the furnaces is now very common, especially in reducing manganiferous ores, but opinion is considerably divided as to the merits of the practice. In the collection of the gas at the furnace top two principal methods have become popular, namely the cup and cone of Parry with gas flues at the side of the furnace, and Langen's syphon taking the gas from the centre and above the charge; although many others are in use. The cleansing of the gas from suspended matter is now more carefully carried out than formerly by the use of depositing boxes and washing drums, which are more especially needed when the ores smelted contain much zinc. In the raw coal furnaces of the west of Scotland the gases are washed to recover ammonia and condensable hydrocarbon, and similar processes are now being applied upon a large scale by Jameson, Carvès,

and Otto to the gases of coke ovens, the first named inventor's method being applied to the ordinary beehive oven of the north of England, while the other two employ the long narrow oven heated by outside flues, such as those of Coppée, Smet, and others.

In the refining of cast iron as a preliminary to its conversion into malleable iron, many processes have been suggested and introduced, such as those of Heaton, Henderson, and Eck, but none have become general, and the same may be said of Bell's and Krupp's methods of dephosphorizing pig metal by molten iron ore in a regenerative furnace, which, though successful, have been superseded by the more generally applicable method of Thomas and Gilchrist.

The direct production of malleable iron from the ore has been realised in several modern processes, such as those of Chenot and Blair, using upright retorts heated externally, and that of Sir W. Siemens, using a gas-heated furnace with revolving cylindrical hearth; but these have scarcely got beyond the experimental stage. The old Catalan forge process, once common in the south of Europe, is now practically extinct, but the allied German bloomery process (often erroneously spoken of as the Catalan) still survives in America, and is even showing a slight increase in production. The open fire process of making malleable from cast iron is now mainly confined to Scandinavia and Russia for the production of steel-makers' converting bars; but, although unchanged in principle, many modifications have been made in details mainly with a view to economising fuel, such as the heating of the blast by the chimney flame and the substitution of reheating furnaces for the wasteful open chafery or nobbling fire.

The puddling process, though constantly threatened with speedy extinction, still retains an important position in iron manufacture, the older grate-fired furnaces being most used. The chief modifications have been increase in the size of the working bed in the so-called double puddling furnace, and the introduction of mechanical movements for the partial or entire suppression of hand labour in working the rabble. Another method of mechanical puddling, that in rotatory furnaces, originally proposed by Menelaus, has been successfully developed by the labours of Danks, Crampton, Spencer, Siemens, and Schneider, but has as yet found but only limited use.

The Bessemer process of making steel and malleable iron by blowing air through molten cast iron, which in 1862 was still to some extent in the experimental stage, has by successive and continuous modifications in constructive and working details, now become of almost equal importance with the blast furnace and puddling furnace in the economy of iron manufacture. It is remarkable, however, that in the more essential points the process remains identical with that first developed on a working scale by the inventor at Sheffield, the bottle or pear-shaped converter with hydraulic tipping gear and cranes being still the characteristic features, although shape has been modified to obtain increased capacity in modern works to a cylindrical straight-necked or "haycock" form with screw-turning gear that allows the cast to be made from either side. The air furnaces, originally used for remelting the pig iron and spiegel, have been replaced by cupolas, and in many cases the latter operation has been superseded by blowing liquid metal taken direct from the blast furnace. Rapidity of working has been especially facilitated by the use of the late Mr. Holley's system of changing the converter bottom, and also his plan of making the body of the converter removable from the trunnion belt. The original semicircular sunk casting pit has also been largely modified, the converter being stilted on piers to allow the ingot mould to stand at the floor level. Increased working space has also been obtained by the system of transfer ladles, the finished charge being removed from the converter pit proper to others containing the ingot moulds. By these and analogous contrivances the yield of a pair of converters has been brought up from 200 to 2000 tons per week. In strong contrast with this, however, is the tendency that has latterly become apparent towards conducting the Bessemer process on a very small scale, using a converter with 6 to 15 cwt. charges, taking the metal directly from the blast furnace and pouring the finished charge into the ingot mould without the intervention of a casting ladle. This has been practised with success at Avesta in Sweden in the production of very soft ingot metal.

The Siemens open hearth process of producing cast steel by dissolving malleable scrap in molten cast iron on the bed of a reverberatory furnace belongs entirely to the period under review, it having become a practical success about 1868, the original or scrap process having been afterwards supplemented by Sir W. Siemens' ore process, in which a part at any rate of the malleable iron is replaced by hematite iron ore. The high temperature required for

the fusion of steel in such large quantities (up to 20 tons at one time) can only be obtained by the regenerative furnace using gaseous fuel and air that have been strongly heated before combustion by circulation through piles of brickwork previously rendered incandescent by the waste heat of the chimney flame. This, beyond increase in size, has received little alteration from the original form, although minor details, such as the position and proportion of the regenerative chambers and gas and air passages have been subjected to considerable variation. Latterly Mr. Frederick Siemens has shown the practice of depressing the furnace roof and other arrangements for making the flame strike into the centre of the hearth to be wrong, and that better results can be obtained by raising the roof so as to form a large combustion chamber in which combination of gas and air may go on without contact with the materials to be melted.

In order to provide for the more uniform heating of the larger open hearth furnaces the fixed bed has, in some cases, been replaced by a round dish revolving about an inclined axis, the furnaces of Pernot and Ponsard being of this kind. These have, however, only found limited application in practice.

Both the Bessemer and Siemens processes in their original forms were only applicable to iron practically free from phosphorous, which has led to the working of hematite and magnetic ores upon an enormously extended scale, almost every accessible deposit in Europe, Africa, and North America being laid under contribution. By the important improvements due to the works of Snelus, Thomas, and Gilchrist, the less valuable oolitic and other iron ores have been rendered available for the Bessemer process by the use of lime or dolomite, both in the converter lining and as a flux, whereby phosphorous may be almost completely removed subsequently to decarburisation. This so-called basic process, though of comparatively recent origin, has already attained a high degree of importance in countries deficient in pure ores, and more particularly on the continent of Europe; but in England and America the older "acid" process, with silicious converter linings, is still predominant. The basic method has also been carried out with some degree of success in the open hearth furnace upon a lime bottom.

For the finer classes of tool and cutlery steel the old method of cementation of Swedish bar iron with charcoal and fusion of the converted or blasted steel maintains its ground with but slight modification. A considerable economy of fuel in the operation of melting has, however, been realised by the substitution of the regenerative gas furnace for the small square air furnace or coke-melting hole.

In the newer processes of steel making the difficulty of obtaining sound ingots has been met in several different ways, such as that by consolidation under hydrostatic pressure, by Sir J. Whitworth; under steam pressure, by Captain Jones; and under carbonic acid gas, by Krupp; while Allen proceeds in the opposite way and drives the gas out of the molten metal by vigorous stirring before pouring. In contrast to these mechanical means are the chemical methods of consolidation by the addition of various elements in small quantities, but more particularly manganese and silicon. In the processes now successfully adopted of casting soft steel to pattern, the use of silicon-manganese alloys is largely concerned.

The progress of forge and mill machinery, consequent upon the introduction of new steel-making processes, has been mainly in the direction of simplification and the addition of mechanical gear for manipulating the heavy masses under treatment. Thus, in rail rolling the trains of spur gearing and reversing clutches are now abandoned in favour of engines without fly-wheels, rapidly reversible by hydraulic gear, which, in some instances, are connected with the mill without any intermediate gearing. In small mills the V-toothed pinions are becoming general, and, to some extent, the American method of driving by straps. The steam hammers used in the forging of heavy ingots for artillery have gone on increasing until they have been made with falling weights of 80 tons, but the tendency at present seems to be to substitute hydraulic forging presses of the kind originally introduced by Haswell. Another substitute for the hammer in compressing ingots is the segmental cogging mill of Ramsbottom.

In reheating furnaces for rolling mills there has been a considerable progress towards the adoption of gas firing, either upon the intermittent regenerative type of Siemens, or some of its simpler modifications working continuously, such as the Ponsard recuperator and the long flue system of Bicheroux and Boetius. Another useful novelty is the retort coking furnace of Price originally used as a puddling furnace. Of greater interest, however, than either

of the preceding is the "soaking pit" of Gjers, which utilises the heat given out by steel ingots in solidifying to bring them to the proper temperature for final rolling, and so allows finished steel objects to be produced with no other fuel than that originally consumed in smelting the ore in the blast furnace.

In the smelting of copper ores the most striking feature is the development of the method originally proposed by Henderson, of extracting small quantities of copper from burnt pyrites by calcination with salt and lixiviating with water, which leaves the iron of the pyrites, formerly wasted as slag, in a form that can be economised by the iron smelter.

This has been improved by Claudet's process of separating as iodide the silver which is almost entirely contained in the first part of the copper liquors and was formerly lost. Another and less convenient method of separating such silver as sulphide has been proposed by Gibb.

In the older smelting processes, gravitating calcining furnaces, such as those of Gerstenhofer, Hasenclever, and Helbig, have been introduced to do away with hand labour in roasting pyritic ores; these are mostly combined with methods for utilising the sulphur gases in sulphuric acid making. In fusion processes tall blast furnaces and cupolas have, to some extent, superseded the Welsh reverberatory form. In America especially cupolas with water-jacketed hearths are in great favour.

Attempts have been made to simplify the Welsh process of smelting by substituting the Bessemer converter for the more gradual methods of concentration in the reverberatory furnace. This, as originally tried with pyritic ores by Hollway, failed, but has since achieved some success as a substitute for the roaster process in producing blister copper from regulus by Manhès of Lyons.

In the refining of copper the principal improvement has been the adoption of Percy's method of producing sound castings by the use of phosphorous in small quantities, which has also been extended to the alloys known as phosphor bronzes. Valuable copper alloy has been formed by the addition of small quantities of other metals, such as manganese, in Parson's manganese bronze, now generally used for large screw propeller and iron in the so-called sterro metal and delta metal. A small proportion of silicon is also used for imparting strength to copper in the alloy called silicon bronze, which possesses great strength, while its electric conductivity is but little less than that of pure copper.

A new departure in copper refining has been made consequent upon the introduction of dynamo-electric machines, namely, the refining of blister copper or rich foreign regulus, electrolytically, the metal being obtained in a very pure state, while foreign matter, including gold and silver, remain behind, in a form convenient for further treatment. This has as yet been only adopted in a small number of instances.

In lead smelting the processes based upon the operations of complete desulphurisation and fritting or actual fusion to slag in the roasting furnace, followed by reduction in large blast furnaces, mainly with water casings, are now very general, and in America the automatic or syphon tap, which allows the operation of casting the reduced lead into pigs to go on continuously, is frequently added to such furnaces.

Parkes's method of desilverising lead by means of zinc, which had remained in abeyance for many years, has now come very generally into use, having almost entirely superseded Pattenson's process of crystallisation. This is in some way due to improvements made in the accessory operations of refining the desilverised lead and the recovery of the silver from the zinc crusts upon which much ingenuity has been expended. Among the former contrivances may be mentioned Cordurié's method of removing zinc by steam at a red heat, and that of dissolving the zinc oxide by carbonate of ammonia. For the distillation of the argentiferous zinc Faber du Faur's bottle-shaped retort and portable furnace is most used. The most important modification of Pattenson's process is that of Luce and Bozanne, who effect the crystallisation by blowing steam through the melted lead and tap off the enriched liquid lead from the crystals, an arrangement that enables steam power to be substituted for hand labour.

The separation of lead from silver has also been effected electrolytically by Keith in America, but as yet only on a small scale.

In the production of zinc numerous improvements in detail have been made in the old processes with a view of economising fuel and more perfectly condensing the reduced metal. The growing scarcity of calamines or oxidised ores has led to the substitution of blende, which neces-

sitates very careful calcination, as well as methods of absorbing the sulphurous gases, such as ordinary acid chambers and towers containing lime water, sulphide of calcium or dolomite. In the reduction of the oxide, gas furnaces such as those of Siemens and Boetius are in favour, and the number of retorts or muffles per furnace is largely increased, as many as 64 muffles and 408 retorts being now heated from a single fire-place. The condensation of the zinc vapour has been improved by increasing the size of the receivers, and filtering the exhaust gases of the retorts through cotton wool, the substitution of aspirators drawing the gases through water for the natural draught, and similar contrivances.

The production of zinc as a continuous operation without the use of retorts has been tried by numerous inventors, but as yet without success. The utilisation of the intimate mixtures of lead, zinc and copper ores known as "bluestone," which cannot be separated mechanically, has been effected on a working scale by a combination of furnace and liquid extraction processes by Maxwell, Lyte, and Parnell.

Among the less abundant metals nickel has come into increased use, as means have been found of depositing it by electrolysis upon brass and other metal work as a hard and very brilliant covering. Sound castings from pure nickel have also been obtained by Fleitmann, by the addition of a small quantity of magnesium to the melted metal.

The metallurgy of silver presents little that is new in principle, although many of the older processes have received important modifications in detail. The European process of barrel amalgamation is now almost abandoned, the American pan process being perhaps most generally used, although the primitive method of amalgamation in open heaps with the assistance of only solar heat is still predominant in Mexico and other Spanish American countries. On the south-west coast of America Kröhnke's process of amalgamation in barrels with subchloride of copper and zinc amalgam has been largely used. Where it is necessary to subject ores to a chloridising roasting, mechanical or gravitating furnaces, such as Brückner's rotator and Stetefeld's tower furnace, are preferred.

Percy and Von Paterson's method of extracting silver by alkaline hyposulphites have been introduced in America, though not to the same extent as amalgamation. A new modification has recently been proposed by Russell in which the silver solvent is a double hydrosulphite of copper and sodium.

In the metallurgy of gold the chief novelties are the general introduction of cast-iron vessels and sulphuric acid as a parting agent in separating gold from silver, and a process founded on the old method of parting by sulphur combined with oxidation by air and the adoption of means of saving the sulphur gases by Rössler. Auriferous copper is also economically treated by subjecting the granulated metal to the slow action of sulphuric acid and moist air, whereby no acid is wasted. The separation of silver in small quantities from gold has been effected by Miller by blowing gaseous chlorine through the melted alloy, and the same process is also used for toughening gold intended for coinage.

The refining and manufacture of the heavy metals of the platinum group, and more particularly platinum and iridium, have received a great impetus from the introduction of Deville's method of fusion in lime furnaces, but the further consideration of the subject belongs rather to general chemistry.

The utilisation of slags from different kinds of smelting processes has not as yet made much progress. The highly phosphuretted slags of the Thomas and Gilchrist process are subjected to chemical treatment to recover the phosphoric acid for use as a manure, while those of the blast furnace when granulated are used in making Portland cement concrete, and to some extent as an improver of the cement. Another product, known as "slag wool" or "silicate cotton," made by blowing air through liquid slag, is used as a non-conducting covering for steam pipes. In America the practice of allowing the liquid slag to run to waste over the ground instead of moulding it into blocks is now very common, and is followed even when it is necessary to remove it for some distance from the furnaces before pouring it out. This is done by using large tanks lined with fire-brick, which are drawn away by locomotives when filled.

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129. TURNOCK, J. R., Yspitty Works, Loughor, South Wales.—Machine for Pickling and Swilling Metal Plates. The model shown is particularly designed for use in tin-plate works.

130. METALLIC SULPHIDES REDUCTION CO. (HOLLWAY'S PATENTS), Limited, 8 Jeffreys Square, London, E.C.—Improvements in the production of sulphur from pyrites and the separation of metalliferous and other substances therefrom by rapid oxidation without the aid of fuel.

134. BENNETT, THOMAS, & SON, 70 & 71 Turnmill Street, Farringdon Road, London, E.C.—Improvements in the process of gold beating.

135. ROYAL MINT (THE), London, E.—Refining Gold by Chlorine Gas, devised by F. Bowyer Miller, Melbourne Mint.

136. SNELUS, GEORGE JAMES, Workington.—Illustrations of Improvements in the processes of manufacture of Steel, and in the apparatus used therefore: (1) Illustrations of the Basic process of dephosphorisation. (2) Apparatus for carrying hot steel ingots. (3) Improved Steel Linings for Gier's soaking pits. (4) Improvements in Moulds for steel ingots, &c.

137. DOCWRA, THOS., & SON, Ball's Pond Road, London, N.—Patent Diamond Drill, for boring for water and prospecting [Guiland's Patent].

138. BRIN FRÈRES, Rue Gavarne 7, Paris.—Production of Gases.

139. BERTET & SISTERON, Grenoble, France (Agents, LYON, J. L., & CO., 8 Love Lane, London, E.C.).—Improved Grinder or Crushing Mill.

140. BARNETT & FOSTER, Niagara Works, Eagle Wharf Road, London, N.—Pumps and appliances for compressing and liquefying gases and application of such gases to scientific and commercial purposes.

141. JORDAN, T. B., SON, & COMMANS, Adelaide Chambers, 52 Gracechurch Street, London, E.C.—(1) Patent Adelaide Rock Drill and Air Compressor. (2) Jordan's Patent Pulveriser. (3) Jordan's Patent Hand-power Rock Drill. (4) Patent Gold Reduction and Mineral Dressing Machinery. (5) Patent Frue Vanner. (6) Patent Adelaide Foundry Sand Mixer. (7) Patent Spring Beam Hammer.

142. CROSSLEY, C. W., 14 St. Mary Axe, London, E.C.—Improved Apparatus for the propulsion, suction, and movement of air, fluids, and gases. The apparatus exhibited shows the invention adapted as an Air Propeller, for moving large volumes of air at low pressure for the ventilation of mines, tunnels, mills, workshops, and buildings; cooling the atmosphere in tropical climates; winnowing; drying processes, and for all similar purposes.

143. ALLDAY, WILLIAM, & SONS, Branston Street, Birmingham.—(1) Alldays' Patent Steel Revolver Improved Root's Blowers. (2) Alldays' Patent Steel Revolver Root's Blowers, with Duplex Engines combined. (3) Alldays' Patent Duplex Blowing and Exhaust Fans. (4) Alldays' Patent Chimneyless Hot Blast Smith's Hearth. (5) Alldays' Patent Branston Fan Forges. (6) Alldays' Climax Root's Blower Forges. (7) Alldays' Patent Screw Pipe Smith's Bellows.

144. BAXTER, W. H. & CO., Albion Street, Leeds.—Improvements in transmitting motion to stone breakers, ore crushers, and other machinery, whereby an irregular movement is given to the jaw, which breaks the rocks with less power, produces better road metal with less waste, and when set for fine crushing the irregular movement prevents the material from sticking in the jaws, and can be regulated to suit any kind of rock.

145. MORRIS & WOOD, West Stockwith, Gainsborough.—(1) Patent Mill for grinding quartz and all other hard substances. (2) Model Patent Cast Iron Attractionless Pulley. (3) Model Patent Railway Truck Coupling.

146. ASKHAM BROS. & WILSON, Limited, Yorkshire Steel and Engineering Works and Crucible Steel Foundry, Sheffield.—(1) A size Lucop's Patent Centrifugal Pulverizer, for hand power. (2) B size Lucop's Patent Centrifugal Pulverizer [in motion], with extra serving arrangement. (3) D size Lucop's Patent Centrifugal Pulverizer for power. For reducing all kinds of ores, gold quartz, phosphates, cement, ganister, limestone, china stones, coal, coke, plumbago, glass, Fuller's earth, pumice stone, sugar, spices, &c., to any required degree of fineness.

147. MASSEY, B. & S., Openshaw, Manchester.—(1) Patent Steam Hammer controlled by foot. (2) Patent Steam Hammer with improved wrought iron framing. (3) Patent Suspended Steam Hammer. (4) Hasse's Patent Power Hammer. (5) Saw for Cutting Metals. (6) Model of Patent Steam Hammer.

148. HALL, C. E., Standard Iron Works, Sheffield.—(1) Stone Breaker and Ore Crusher; also Model of multiple action stone breaker, with jaws working alternately and in equilibrium. (2) Pulveriser, with three rollers, fitted with patent friction clutch instead of fast and loose pulleys, specially arranged for reducing ores and other refractory material. (3) Victor Bone Mill, with three rollers—two crushing, one pulverising. (4) Coal Washing and Drying Machine, illustrated by drawings.

149. HUSBAND, WILLIAM, Hayle, Cornwall.—Oscillating Cylinder Stamper. Small size specially constructed for stamping soft rock or ore bearing sand or gravel. Large sizes, with heads weighing 10 cwt. each, are at work crushing hard rock in quantities for each head of 26 tons for 24 hours.

150. RHODES, J., & SONS, Grove Iron Works, Wakefield, Yorkshire.—Machinery for working sheet metals.

151. CRANSTON, JOHN GREY, 22 Grey Street, Newcastle-upon-Tyne.—(1) Patent Rock Drills for driving tunnels, sinking shafts, quarrying, railway cutting, and submarine work. (2) Heppell and Cranston's Patent Machine for cutting coal.

152. ATCHERLEY, DR. R. J., 37 Ashchurch Grove, Shepherd's Bush, London, W.—Continuous Mercurial Rain Amalgamator for saving Float and Flour gold.

153. CASSEL, HENRY R. (care of ALLISON BROTHERS, 52 Chancery Lane, London, W.C.)—Extraction of Gold from Refractory Ores by Electrolysis.

154. ELECTRO-AMALGAMATOR CO., Limited (THE), Tower Chambers, Moorgate, London, E.C.—Improved method of extracting gold and silver from their ores by the combined action of electricity and mercury.

155. CARR, C., Grove Lane, Smethwick, Birmingham.—Crucible Melting Furnaces, for gold, silver, and all precious metals; also for gun metals, brass, iron, steel, &c.

156. THOMAS, S. G., & P. C. GILCHRIST, 9 Bridge Street, Westminster, London, S.W.—The Basic or Thomas Gilchrist's Process for making steel and ingot iron from phosphoric pig in the Bessemer and Siemens' furnaces.

157. KAY, L. R., 24 Solon New Road, Bedford Road, Clapham, London, S.W.—Improvements in the coating and preservation of metals.

158. GIBBONS, HENRY, Kennet Works, Hungerford.—(1) Patent Moulding Machine for producing castings with speed and accuracy. (2) Patent Machine for grinding spiral cutters and bottom blades of lawn mowers. (3) Patent Safety Lock and Bolt.

159. USKSID ENGINEERING & RIVET CO., Limited (THE), Uskside Iron Works, Newport, Mon.—Underground Self-contained Hauling Engine.

160. RIO TINTO CO., Limited, 30 St. Swithin's Lane, London, E.C.—Model of the Open-Cast on the South Lode of the Rio Tinto Mines, Spain. The model executed by Mr. C. N. Thwaite, 23 Commercial Road, Peckham, London, S.E.

161. DICK, ALEX., 110 Cannon Street, London, E.C.—Delta Metal.

162. PHOSPHOR BRONZE CO., Limited, 87 Sumner Street, Southwark, London, S.E.—(1) Phosphor Bronze Alloys for bearings and parts of machinery. (2) Silicium Bronze Wire for telegraph and telephone lines, electric lighting, and other purposes.

163. MANGANESE BRONZE & BRASS CO., Limited (THE), St. George's Wharf, Deptford, London, S.E.—(1) Manganese Bronze for heavy castings, such as propellers cast under pressure for ordnance purposes, forgings, shafts, sheathing plates, bearings, wire, &c. (2) White Brass for axle brasses; do. for filling bearings.

164. FOSTER, J., & SONS, Bow Lane Iron Works, Preston.—(1) Percussive Rock Drills. (2) Tripods and Tunnelling Carriage.

165. HUMBLE, STEPHEN, 5 Westminster Chambers, Victoria Street, London, S.W.—(1) King & Humble's Patent Safety Detaching Hook, with automatic lowering gear, for the prevention of overwinding at mines. (2) Safety Cage to suspend in shaft in case of fracture of winding rope. (3) Humble and Mellor's Patent Safety Miners' Lamp. (4) Snowden & Humble's Patent Antibreakage Coal, &c., Loading Apparatus for vessels. (5) Humble's Patent Safety Blasting Plug for mining, quarrying, and other blasting purposes, also applicable for the bursting of guns.

166. ROBEY & CO., Globe Works, Lincoln.—12-HP. Improved Robey Winding Engine and Locomotive Boiler Combined, mounted on patent wrought-iron tank foundations, specially adapted for export and for places where materials for foundations are difficult and expensive to obtain.

167. GLOVER & HOBSON, Albert Iron Works, St. James' Road, Old Kent Road, London, S.E.—(1) Macdermott's Patent Coal Perforator. (2) Macdermott & Glover's Patent Hand-labour Rock Perforator.

168. TYLER, HAYWARD, & CO., 84, 85 Whitecross Street, London, E.C.—(1) Hayward Tyler & Co.'s Universal Steam Pumps for mining and general purposes; the pumps fitted with india-rubber ball valves, in gun-metal seats, suited for high speeds; the steam cylinders with internal valve moved by the steam, thus having only two moving parts. (2) Hayward Tyler & Co.'s Universal Steam Pump for high lifts or hot water; the pump fitted with gun-metal valves; the cylinders with external steam-moved valve. (3) Hayward Tyler & Co.'s Pumping Engines for mining and other purposes, with self-governing valve gear, giving regularity of stroke and entire security against running away if water fails. Suited for very high lifts, and also for water works, &c. (4) Hayward Tyler & Co.'s Universal Steam Pumps for boiler feeding, and as fixed to fire engines, &c.

169. HAND POWER ROCK DRILL CO., Limited, 4 Cophall Buildings, London, E.C.—(1) Jordon Burton's Patent Hand-power Rock Drill.

170. BUCKTON, JOSHUA, & CO., Limited, Well House Foundry, Meadow Lane, Leeds.—50-ton Testing Machine with Patent Autographic Indicator attached.

171. TARBUTT & QUENTIN, 75 Lombard Street, London, E.C.—The Duncan Concentrator. A machine for the automatic, rapid, and effective concentrations of all classes of ores and of tailings.

172. PYRITES SMELTING CO., Limited, 38 Threadneedle Street, London, E.C.—Huntington and Koch Amalgamating Apparatus for Gold and Silver Process for extracting precious metals from their ores.

173. SCOTT, ERNEST, & CO., Close Works, Newcastle-on-Tyne.—Scott and Hilder's Machine for extracting iron from other substances by means of electro-magnetism. By its use engineers' refuse and mould borings are speedily rendered valuable; while ore can be very economically worked in it. Special attention is invited to the automatic manner in which the iron is released from the magnets.

174. SHEPPARD, CHAS., Bridgend, South Wales.—(1) Coal-washing Machine [model]; Elevators and Conveyance Screws, full size. (2) The Dead Weight Crushing Mill [model].

175. HATHORN & CO., 22 Charing Cross, London, S.W.—(1) Patent Eclipse Rock Drills and Tripods. (2) Patent Reliance Air Compressors. (3) Patent Hydraulic Tunnel Cars. (4) Patent Hydraulic Tunnel Columns. (5) Patent Excelsior Steam Engine.

176. AQUEOUS WORKS & DIAMOND ROCK-BORING CO., Limited, Crown Works, Guildford Street, Lambeth, London, S.E.—Improvements in Rock-boring Apparatus.

177. COMPRESSED LIME CART-RIDGE CO., Limited (THE), 3 Queen Street, Cheapside, London, E.C.—Improved Method of and Apparatus for breaking down and getting coal and other minerals in mining, quarrying, or tunnelling operations.

178. LATCH, ARTHUR, 23 Great George Street, Westminster, London, S.W.—Improvements in the construction of metal ropes, strands, bands, cables, tubes, &c.

179. PICHLER, S. FRANCIS, 162 Great Portland Street, London, W.—Balance Double-acting Man Engine. An application of a lift adapted for use in mining, in lieu of rope, chain, cage, &c.

180. STABLES, JAMES WALTER, 16 Wensleydale Parade, Birstall, near Leeds.—Apparatus for arresting or stopping the descent of cages in mines on the breakage of the rope, and for preventing overwinding of the cage. The apparatus is specially designed for cages running on guide-ropes, but it can be adapted so as to act equally well on wooden guides.

181. LAMPEN, GEORGE J., & CO., Ings Road Iron Works, Wakefield.—(1) Patent Clip Pulley. (2) Skimmer for fixing in boilers. (3) Drills. (4) Patent Signal Bells. (5) Self-acting Hoist Protection. (6) Safety Porch Lamp.

182. LEWIS, W. T., & W. H. MASSEY, Aberdare, South Wales; and Twyford, Berks.—(1) Automatic Gear for the prevention of overwinding. (2) Half-size Model showing the application of a simple form of this automatic gear to the steam valve and reversing levers of an ordinary winding engine.

183. BROWN, THOS. & WM., 206 Manchester Road East, Little Hulton, near Manchester.—Patent Safety Catch for wire rope guides, to prevent accidents from the breakage of the rope, band, or chain, by which the cage or other such arrangement is held or suspended.

184. DAVIDSON, G., & CO., Chester le Street, Co. Durham.—Improvements in Hooks or Connections for Mine Cages for preventing accidents due to overwinding.

188. KITTO, PAUL, & NANCAR- BOW, Llanidloes, Montgomeryshire.—Automatic Discharging and Righting Ship.

189. ELLIOTT'S PATENT MINING PICK CO., Limited, 32 Kennedy Street, Manchester.—Improvements in Axes, Hammers, Spades, Shovels, &c., and Picks for mining, military, and other purposes.

190. WARSOP, THOS., Conniston, near Ambleside.—Interchangeable Colliers' or Miners' Pick. This invention is equally applicable to every article or tool which requires to be expanded into an orifice.

192. ASQUITH, ORNSBY, & NICHOLSON, Seaton, Delaval, Northumberland.—Improved Apparatus for detaching coal and stone.

193. CLARK, E. STANLEY, Penryn, Chester Road, Wrexham.—Improvements in or relating to blasting with explosives, and in cartridges and compositions to be used therein.

194. HOLMAN BROTHERS, Camborne Foundry and Engine Works, Camborne, Cornwall.—The Cornish Rock Drill fixed on Column and also fixed on Tripod.

195. BICKFORD, SMITH, & CO., Truckingmill, Cornwall; London Office: 5 Gracechurch Street, E.C.—Safety and Instantaneous Fuses and Igniters for use in all blasting operations.

196. BRITISH & FOREIGN SAFETY FUSE CO.; Works: Redruth, Cornwall; London Offices: 3 & 4 Adelaide Place, London Bridge, E.C.—Safety Fuse for blasting purposes, railway, mining, quarrying, and submarine operations.

197. GLOVER, ARTHUR, Galley Hill, Swanscombe, Kent.—Eccentric Rotary Sieve, with movable panels, enabling different mesh wires to be readily adjusted.

198. BOWER, GEORGE, St. Neots, Hunts.—Drawings of a Bower-Barff Furnace and Specimens of Iron and Steel rendered rustless by the process, which consists in subjecting articles when at a red heat to the action of superheated steam or air, by which the iron combines with the oxygen and produces a coating of magnetic oxide, which is not affected by ordinary atmospheric conditions.

199. CALOE, WILLIAM, Eastwood Lane, Rotherham.—Improved Apparatus for locking motties or checks to pit corves or other waggons. This invention is to do away with the present insecure method employed, and the unpleasantness which often arises from the loss or removal of motties.

201. BARROW ROCK DRILL & ENGINEERING CO. (THE), Saltash, Cornwall.—Rock Drill [Hosking and Blackwell's Patent].

202. MACGEORGE, E. F., late Melbourne (Agents, McLEAN BROTHERS & RIGGS, 52 Queen Victoria Street, London, E.C.).—Clinograph or Bore-hole Test. For mapping and utilising the well-known, often serious, deviations of boreholes; also strata and veins traversed.

203. ASQUITH, T. W., & R. E. ORNSBY, Seaton-Delaval, Northumberland.—Improved Apparatus for drilling round, smooth, straight, and level holes in coal and other minerals.

204. STEPHENS, R., & SON, Wheal Croft Works, Carn Brea, Cornwall.—Patent Air Valve Rock Drills.

205. TURNER, F. W., 61 King William Street, London, E.C.—Slate-sawing Machine.

206. MIDFORD FULLER'S EARTH WORKS, Limited (THE), Bath.—Improvements in the preparation of Fuller's Earth for cloth manufacturing purposes; also for oil refining and domestic use.

207. ATKINSON, B. F., 3 Hemming's Row, Charing Cross, London, W.C.—A Separator for separating gold, silver, and other metals from their ores or gangue.

208. **BAILEY, W. H., & CO.,** Albion Works, Salford, Manchester.—(1) Hydraulic Hauling Engine [Haag's Patent, Sir Hussey Vivian Pattern]. This type of engine was designed for working at a pressure of 1200 feet of water in column, for Sir Hussey Vivian's Nickel Silver Mines in Norway. (2) One-horse Water Motor of a similar type used by printers and others where town water of requisite pressure is available. (3) Bailey and Reid's Cement Tester, as used for testing cement, and the concrete blocks required in the construction of the new Eddystone Lighthouse. (4) Oil Tester [Prof. Thurston's patent]. This instrument is for testing the lubricating value of oil.

209. **BOHLER BROTHERS & CO.,** Saville Street, Sheffield.—Utilisation of the spathic and brown ores of the Styrian Alps in the production of steel by the direct process, only charcoal being used for fuel; also samples of Bessemer and Bessemer Martin steel from the same ores.

210. **SIMON, HENRY,** 20 Mount Street, Manchester.—(1) Coke Ovens [Simon-Carrès Patents], with continuous recuperation of heat and recovery of tar, ammonia, benzol, &c. (2) Samples of Coke and Residuals obtained by these ovens. (3) Drawings.

BROWN, J. D., & CO., 49 Fenchurch Street, London, E.C.—Blast or Cupola Furnaces.

BESSEMER, SIR HENRY, Denmark Hill, Surrey.—Original Test Samples of Bessemer iron and steel, dating as far back as August, 1856.

TRUSSELL, THOMAS, Mine Surveyor, 4 Arrow Terrace, Fisher Gate, Nottingham.—Improvements in the method of securing picks to their shafts.

BEAUMONT, JONES, & CO., 37 Walbrook, London, E.C.—(1) Improvements in apparatus for subaqueous boring. (2) Improvements in apparatus for boring rocks.

DEIGHTON, W., Workington, Cumberland.—(1) Double Reverse Rolling Mill for rolling large ingots to any section required for finishing rolls. (2) Combined Three High and Reverse Rolling Mill. (3) Hydraulic Casting Crane for steel works.

ALLEN, S. SEALY, 12 Woodstock Road, Bedford Park, Chiswick, London, W. (See Group IV.)

ANDERSON & GALLWEY, Cremorne Works, Lots Road, Chelsea, London, S.W. (See Group XI.)

APPLEBY BROS., 89 Cannon Street, London, E.C. (See Group XI.)

ASBESTOS COMPANY, Limited (THE UNITED), 161 Queen Victoria Street, London, E.C. (See Group IV.)

ATTWOOD & CO., Canal Head Foundry and Engineering Works, Ulverston, Lancashire. (See Group XI.)

BAGOT, A. C., 42 Lowndes Street, London, S.W. (See Group XIII.)

BAKER, A., 14 Warwick Gardens, Kensington, London, W. (See Group III.)

BAXTER, S., & CO., 18, 19 Great St. Helens, London, E.C. (See Group VII.)

BECK & CO., Limited, 130 Great Suffolk Street, Southwark, London, S.E. (See Group IV.)

BERNAYS, JOSEPH, 96 Newgate Street, London, E.C. (See Group XI.)

BOLTON, REGINALD, Dashwood House, New Broad Street, London, E.C. (See Group IV.)

BROADBENT, ROBERT, & SON, Phoenix Iron Works, Staylbridge, Cheshire. (See Group X.)

BROCKELBANK, T. A., 34 Rylett Road, Shepherd's Bush, London, W. (See Group V.)

BROWN, J. D., & CO., 49 Fenchurch Street, London, E.C. (See Group III.)

BUCKLEY, W., & CO., Patent Piston Works, Millsands, Sheffield. (See Group IV.)

BUTLER, SAMUEL, 127 Buta Road, Cardiff. (See Group XI.)

CLUTTERBUCK, WILLIAM, 19 Victoria Road, Kilburn, London, N.W. (See Group III.)

COALBROOKDALE CO., Limited, Coalbrookdale Iron Works, Shropshire. (See Group IV.)

CROMPTON, R. E., & Co., Mansion House Buildings, London, E.C. (See Group XIII.)

DURHAM, CHURCHILL, & CO., 23 Leadenhall Street, London, E.C. (See Group IV.)

EDWARDS, G. M., 54 Gresham Street, London, E.C. (See Group III.)

ELLIS, W., Great Week, Chagford, Devon. (See Group I.)

FALL, E. M. B., 30 Manley Terrace, Kennington Park, London, S.E. (See Group IV.)

FIELDING & PLATT, Atlas Iron Works, Gloucester. (*See Group XI.*)

FOX, EDWIN, & CO., Limited, Magnetic Telegraph Wire Works, Millwall, London, E. (*See Group XIII.*)

GILBERT, GLOSSOP, & STACEY, Heeley Bridge Foundry, Sheffield. (*See Group XI.*)

GLOSSOP & STACEY, Heeley Bridge Foundry, Sheffield. (*See Group XI.*)

HATHORN, DAVEY, & CO., Leeds. (*See Group XI.*)

HEMMINGWAY, JOHN I., Dixon Street, Penistone Road, Sheffield. (*See Group IV.*)

HUMBLE, STEPHEN, 5 Westminster Chambers, Victoria Street, London, S.W. (*See Group V.*)

JACKSON, J., 8 Frederick Place, Gray's Inn Road, London, W.C. (*See Group IV.*)

JENKIN, F., 3 Great Stuart Street, Edinburgh; and 53 Old Broad Street, London, E.C. (*See Group XIII.*)

JONES, R. K., Eureka Works, Birkenhead. (*See Group X.*)

KERR, STUART, & CO., 20 Bucklersbury, London, E.C. (*See Outside, South Promenade.*)

KINETIC ENGINEERING CO. (THE), 96, 37 Brooke Street, Holborn, London, E.C. (*See Group XIII.*)

KIRKALDY, JOHN, 40 West India Dock Road, London, E. (*See Group IV.*)

KITSON & CO., Airedale Foundry, Leeds. (*See Group IV.*)

LANE, HOWARD, & CO., 115 & 117 Palmerston Buildings, Old Broad Street, London, E.C. (*See Group IV.*)

MADAN, C. SPENCER, 21 Manchester Chambers, St. Ann's Square, Manchester. (*See Group IV.*)

MARSDEN, H. R., Leeds. (*See Group C.*)

MORTON, A., & THORNTON, 96 Buchanan Street, Glasgow. (*See Group V.*)

MUNICIPAL APPLIANCES CO., Limited (THE), 37 Victoria Street, Liverpool. (*See Group III.*)

PATENT (METAL) DIE CO., Limited, 29 Addington Street, York Road, London, S.E. (*See Group XI.*)

PULSOMETER ENGINEERING CO. (THE), Limited, Nine Elms Iron Works, London, S.W.; and 61 & 63 Queen Victoria Street, E.C. (*See Group XI.*)

RICHTER PATENT ECONOMISER MANUFACTURING CO. (THE), West End Mills, Longside Lane, Bradford. (*See Group IV.*)

ROSS, LIEUT.-COL. W. A., Acton House, Acton. (*See Group XXVIII.*)

ROWELL, GEORGE, M.D., Falcon Road, London. (*See Group XXV.*)

SENNETT, A. R., & CO., 62 Hatton Garden, London, E.C. (*See Group XIII.*)

SIEMENS, F., 12 Queen Anne's Gate, Westminster, London, S.W. (*See Group XVI.*)

SOUTH-EASTERN RAILWAY CO. & SUBMARINE CONTINENTAL RAILWAY CO., London Bridge Station, London, S.E. (*See Group III.*)

STARNES, J. S., & SONS, 13 Broad Street, Ratcliffe, London, E. (*See Group VII.*)

STOREY, A. H., 38 Lindore Road, Wandsworth, London, S.W. (*See Group XXV.*)

TRIER BROS., 19 Great Suffolk Street, Southwark, London, S.E. (*See Group IV.*)

TURNER, R., & SONS, Old Factory, Redditch. (*See Group XVIII.*)

UNIVERSAL ELECTRIC LIGHT & ENGINEERING CO., 13 & 14 King Street, Cheapside, London, E.C. (*See Group XV.*)

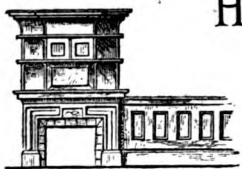
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WAYGOOD, R., & CO., Falmouth Road, Great Dover Street, London, S.E. (*See Group XI.*)

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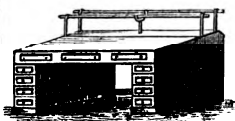
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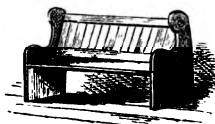
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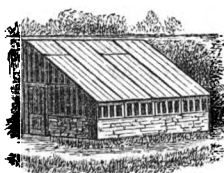


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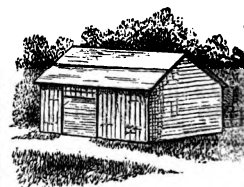


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ENGINEERING CONSTRUCTION AND ARCHITECTURE.

BY ARTHUR T. ATCHISON, M.A.

A BRIEF review of the work accomplished since the year 1862 in the wide field of Engineering Construction and Architecture shows that much solid progress has been made.

In the formation of macadamized roads but little change has to be recorded; the principles and practice of Telford and Macadam have been closely followed, but the general use of horse and steam rollers in urban districts has made newly metalled roads passable for wheel traffic from the first—the road has in fact been made for the traffic instead of by the traffic. In paved roads much more attention has been given to the substructure, the use of concrete, to form a uniform and unyielding foundation for the sets or blocks, has become general. The use of granite sets has greatly extended where the traffic is of the heaviest class, and asphaltic paving has been introduced, and is largely employed in Paris and in the city of London. Many systems of paving with deal blocks set on end have been successfully established, chiefly owing to the universal adoption of a solid concrete foundation, which was wanting in the earlier trials.

In the cleansing of roads there has been very little advance in the mechanical means employed; horse brushes, scrapers, and elevators are very partially used, and with each advent of wet weather the far-famed London street mud holds its sway alike in Whitehall and Whitechapel, and stoutly upholds the vested interests of the crossing-sweeper and the dressmaker, much of whose gains would be swept away with it.

In the construction of railways the most important improvement has been the introduction of steel rails. On May 2, 1862, two 21-ft. steel rails were laid at the Chalk Farm bridge on the London and North Western Railway for comparison with the ordinary iron rails, and were taken up in August, 1865. During that time they had been exposed to the traffic of 9,550,000 engines, trucks, &c., representing 95½ million tons, and had outlasted sixteen fuses of the iron rails while only showing a wear of about a quarter of an inch. It was pointed out that, even at the price of £15 per ton then ruling, the use of steel rails showed an important saving compared with iron, all charges for maintenance and interest on the original outlay being added in both cases. Owing mainly to the introduction of the Bessemer process, the demand for steel rails has grown year by year, and it is estimated that the annual production throughout the world has now reached 4,000,000 tons.

In connection with railways many works of unprecedented magnitude and difficulty have been accomplished. The Mont Cenis tunnel, 7½ miles in length, traversing various strata of rock, many of which were of the hardest character, was commenced by hand labour in 1858. In the first five years the rate of progress by this means was 1·655 feet per day at the Modane end. The introduction by M. Sommeiller of compressed air rock-drills driven by water power marked a great advance, and the rate of progress increased to 3·686 feet in 1863, and further to 6·695 feet per day in 1870, while at the Bardonnèche end the rates were 2·148 feet by hand, 3·411 by machine in 1862, and 7·989 in 1870. The work was completed in 1871, having thus occupied fourteen years. The St. Gothard tunnel, 9½ miles in length, commenced in September, 1872, was completed and opened for traffic January 1, 1882, having occupied nine years and two months. The advanced heading was driven at the rate of 6·63 feet per day at first, increased subsequently to 10·11 feet per day by the adoption of the Ferroux drill. The headings, starting 9½ miles apart, met with a deviation not exceeding 4 inches vertically and 8 inches horizontally in less than seven and a half years' work, the greater progress being due to the improved rock-drills, the use of dynamite and compressed air locomotives.

In the Arlberg tunnel, 6½ miles in length, which will form the connection between the Swiss and Austrian railway systems, an advance of 10 feet per day is made at one end by drills similar to those employed at the St. Gothard, at the other end 15½ feet per day with Brandt's hydraulic borer.

In this country the Severn tunnel, 7942 yards in length, of which $2\frac{1}{2}$ miles are under the estuary, 96 feet deep in one part at high tide, is rapidly approaching completion. The large quantity of underground water met with caused unusual difficulties and some temporary stoppages. The Mersey tunnel, 3820 yards in length, through red sandstone, of which 1300 yards are under the river, is now completed. In the heading from the south side, a boring machine, invented by Colonel Beamont and Captain Fisher, has been employed. In this machine a bore-head 7 feet in diameter, fitted with discs or cutters of chilled cast iron, is rotated against the rock face by compressed air engines. The cutters can be turned round as they wear, thus bringing a fresh edge to bear. The machine is advanced $\frac{3}{4}$ inch each revolution, and has bored 15 feet in twenty-four hours.

Great advance has been made in mechanical appliances for excavation; Milroy's excavator, first used on the works of the Glasgow Union Railway bridge over the Clyde, enabled cylinders 8 feet in diameter to be sunk 25 feet through sand in ten hours, 70 cubic yards of sand being brought up in a depth of 50 feet of water, and in its latest developments as the hydraulic dredger it is still more effective. For deepening harbours and river channels the American clam-shell dredger, as in use at Quebec Harbour, takes out 1200 cubic yards per day, working in compact sand. The steam navy, though designed many years before, has only assumed a practical shape in the last ten or twelve years. It is now largely used in works where a great bulk of excavation has to be removed: it can deal successfully with stiff clay and even with chalk cuttings, and will excavate and fill into wagons from 300 to 600 cubic yards per day at an average saving over hand labour of 3d. to 1s. per yard.

A system of railways, affording means of communication between the various parts of the metropolis, has now been completed by the construction of the closing link of the Inner Circle. Thirteen miles of main line, exclusive of numerous junctions and branches, have been constructed throughout below the level of the adjoining streets. The number of passengers carried, which on the part of the line first opened amounted to 9½ millions in 1863, has during the past year reached 114½ millions. The running of eighteen and nineteen trains per hour each way on the busiest parts of these railways over the numerous junctions and crossings, and that too with an almost complete immunity from accidents, shows the perfection to which railway working has now been brought.

In New York, between the years 1875-9, thirty-four miles of elevated railways have been constructed. The line is carried by girders resting on columns ranged in the line of the curb in most parts. In some streets the two lines of railway are independent, each being carried on a single line of columns by a pair of longitudinal main girders; in others they are carried on cross girders spanning the street's width between the main girders. The gauge is 4 feet 8½ inches, and the weight of the locomotives used is 19½ tons. The average number of passengers carried daily is 165,000.

A method of traction, invented and patented in 1811, has been introduced for ascending steep gradients, the first example being the Rigi Railway. This line is worked by means of a toothed driving wheel gearing with a racked rail; it is 3½ miles in length and rises 3930 feet, the steepest gradient being 1 in 4, extending for one-third of the length. As a consequence of the success of this line, several other steep grade lines have been constructed. The cone of Mount Vesuvius is surmounted by a rope incline half a mile in length worked by a stationary engine with gradients varying from 1 in 2½ to 1 in 1.6. As a comparison with what has been done by the ordinary methods of railway traction, the Peruvian railway from Callao and Lima to Oroya may be mentioned; this line, 105 miles in length, rises by gradients of 1 in 33 to a height of 15,600 feet above sea level.

Street tramways, although tried experimentally in short lengths some years earlier, were first introduced, in their present form, with a grooved rail, into Liverpool in 1867 and London in 1870. In their early days a comparatively light iron rail laid on a longitudinal timber sleeper was used, well enough adapted to the requirements of the cars, but it was soon found that all the heaviest street traffic sought the easier traction afforded by the rail, causing great wear and tear. In the more modern lines, therefore, a heavier steel rail laid on longitudinal iron sleepers is generally adopted. In San Francisco, Chicago, and more recently at Highgate Hill, an endless wire rope running on sheaves in an underground channel between the rails, worked by a stationary engine, takes the place of horses. The cars are attached to the rope by a gripper

passing through a slit in the pipe forming the channel. Gradients of 1 in 6 are easily surmounted, and the rope is readily gripped or released, and the cars rapidly started or stopped. At Chicago two of these lines are each above two miles in length, each worked by one length of steel wire rope $1\frac{1}{2}$ inch in diameter.

In bridges and viaducts the introduction of steel permits lighter structures and longer spans; drilled rivet holes have largely taken the place of punched holes; hydraulic riveting is replacing hand work, the system of pin connecting has found but little favour in this country since the completion in 1863 of one of its best examples, the Charing Cross bridge, though it is almost exclusively used in America in large structures. For foundations, iron cylinders and caissons have taken the place of coffer dams.

Amongst the most remarkable bridges erected since 1862 may be mentioned the International Bridge over the Niagara River, 3651 feet in length, with a swing portion of 364 feet, covering two spans of 160 feet, which can be opened or shut in one minute by steam power. At the site of the bridge the river has a greatest depth of 48 feet, with a current of from 6 to 12 miles per hour. The Kentucky River bridge, consisting of three spans of 375 feet, with a height of 275 feet above low water at the centre, was built out from the two sides of the ravine simultaneously, with no other staging than a temporary timber pier at the centre of each of the two land spans. The junctions of the different members at the centre were effected one at a time by slackening or keying up the lateral bracing and taking advantage of the range of temperature (30° Fah.) between night and day. One of the earliest steel bridges was that constructed at Glasgow, U.S.A., about 1878, consisting of five spans of 311 feet. Hay steel was used of an elastic limit of 48,000 to 55,000 lbs. per square inch, and an ultimate strength of 80,000 to 100,000 lbs. Tested with a load of two heavy trucks and a locomotive placed at the centres of the spans, the deflections varied from 1.56 to 1.8 inches. Each span weighs about 100 tons less than an iron one of equal strength.

At St. Louis an arched bridge has been constructed, mostly of steel, with two spans of 500 feet and a central span of 520 feet with a rise of 59 feet. It has two platforms, a carriage road and footways above and railway lines below, the width being 54 feet. The arches consist of four ribs, each formed of two lines of steel tubes 12 feet between centres stiffened by diagonal bracing. The tubes are built up in 12-foot lengths of six steel staves, varying in thickness from the centre to the springing, secured by a light steel casing, and butting at their ends on a collar by which adjoining lengths are connected to each other and to the bracing. The arch ribs were erected by building out asymmetrically from the piers, the sag of the rib being prevented by tie-bars brought up to a timber tower erected on the pier and with a similar arrangement at the abutments with an anchorage ashore. Much difficulty was experienced in making the junction at the centre of the two halves of the arch ribs, as their accurate meeting could not be effected in most cases; this was, however, overcome by taking advantage of changes of temperature, and by making special junction lengths of tube. The foundations of the two piers were carried down to the rock, at depths of 76 and 105 feet, by means of caissons provided with air-locks, and a working chamber at the bottom, the water being excluded by air pressure.

The East River Bridge, connecting Brooklyn and New York, has a central span of 1595 feet, and two side spans of 930 feet; the height above high water is 135 feet at the centre, and 278 feet to the top of the towers. The platform, 85 feet in width, is suspended from four cables, each consisting of 19 strands of 332 parallel wires, No. 7 gauge, made from crucible cast steel. Each cable thus contains 6308 wires, having together an ultimate strength of 10,730 tons. To build up a strand the single wire is passed round a grooved wheel or "travelling sheave," which is then attached to an endless rope running round pulleys at the two anchorages on the river banks; one end of the wire is made fast at the starting point, and the endless rope being set running, the wire is paid out from a drum, and a double length of wire is thus carried across to the other anchorage, the lengths are adjusted to the corresponding deflection of a guide wire suspended in position, and the wire is made fast. The separate strands, when completed, were pressed tightly together with clamps, and the whole covered with a wrapping of wire.

A novelty in design is shown by the Douro Viaduct, which crosses that river near Oporto. The central span is supported by a crescent-shaped braced arch 200 feet from the water level to

the extrados, and 525 feet between the springings; the arch was built out from the abutments, the overhanging ends being supported by steel wire ropes. The roadway is carried by a lattice girder resting on the crown of the arch and on two intermediate piers built on the arch. The arch is hinged at the springings, and when tested by a train of 352 tons weight, running at 14 miles per hour, showed a deflection of only .67 inch at the crown without any appreciable oscillation.

The Kinsua Viaduct on the New York, Lake Erie, and Western Railway is remarkable for its great height, the rail level being 302 feet above the bed of the stream.

In this country the two most remarkable works now in course of construction are the new Tay Bridge, 10,780 feet in length, divided into 85 spans, and the Forth Bridge, which will vastly exceed in size and strength anything hitherto attempted in bridge building. It will consist of two spans of 1700 feet, two of 675 feet, 14 of 168 feet, and six of 50 feet, with a headway under the largest spans of 150 feet. The two largest spans, and the two adjoining them, will consist of cantilevers built out from the three piers for a distance of 675 feet, the intermediate space, in the case of the former, being bridged by a girder of 350 feet span, and in the latter their ends reach the next piers. The main piers will each consist of four masses of masonry, 45 feet in diameter at the top and 70 feet at the bottom, spaced 120 feet between their centres transverse to the bridge, and longitudinally 270 feet at the centre pier, and 155 at the other two. The cantilevers will be 350 feet in height at the piers, the main compression members will be steel tubes from 5 feet to 12 feet in diameter. The weight of steel used in the superstructure of the large spans will be about 42,000 tons, and the total length 8084 feet, including the viaduct approaches. In the design of this bridge numerous new problems have had to be dealt with which in a work of ordinary dimensions could be neglected; thus, the horizontal struts at the top of the two pairs of masonry columns forming a pier employed to transmit the horizontal opposing thrust of the cantilevers could in an ordinary structure be considered inelastic, but here, being 270 feet in length, their compression under the thrust is calculated to amount to $1\frac{1}{2}$ inches, and special arrangements have to be made to allow of this during erection.

In the general plan of docks and harbours the principal changes to be recorded are the steadily increasing size and depths necessitated by the increasing size of shipping. The employment of hydraulic machinery in the working of docks has become general; by this means the power of a stationary steam-engine is made available at various places for opening lock-gates, working capstans, coal hoists, and cranes fixed or movable.

Among the most important works in this class is the Holyhead New Harbour, commenced in 1847 and completed in 1878. A sheltered harbour of 667 acres has been formed by the construction of a breakwater, extending 7860 feet from the shore, consisting of a massive stone superstructure built on a rubble mound. Seven million tons of rubble stone were used in forming the mound, obtained by the firing of one thousand mines, the largest of which dislodged 130,000 tons of rock. Cement concrete blocks of large size have been of late years chiefly used for works designed to resist heavy seas, such, for instance, as the breakwaters of Madras, Kurrachi, Table Bay, Colombo, while at Aberdeen and Wick the concrete has been deposited *in situ* in a liquid state within timber moulds, so that the entire work becomes a monolithic mass.

In the building of quay walls a new method has been adopted at Dublin to dispense with cofferdams, or setting masonry by divers. The wall is built from the base 24 feet below low water to 3 feet above low water, in single blocks 27 feet high, 21 feet 4 inches wide, and measuring 12 feet in the length of the wall. These blocks, weighing 350 tons, are built of rubble masonry on a quay, and when set are picked up by floating shears, carried off and lowered into position. Some new methods have been introduced for docking ships: thus, in the Hydraulic Lift Graving Dock a vessel is placed over a submerged pontoon, which is then lifted bodily by two rows of hydraulic presses, working in cast-iron columns, which act as guides. When lifted to the required height the pontoon empties itself through valves, which close when the presses are again lowered; the vessel is then borne by the pontoon, and is floated away to a repairing berth, leaving the lifts ready for another pontoon and the next vessel. Slipways worked by hydraulic cylinders are also used for the same purpose; by this means at Pennarth a vessel of 2500 tons displacement can be placed on a cradle and hauled up

high and dry in two hours. As typical of another new method, the Bermuda Floating Dock is one of the best examples. This dock has a floating power of 16,000 tons, and employed 8000 tons of iron in its construction; it was towed from the Thames to Bermuda in 1869.

In the building and lighting of lighthouses great advance has to be recorded; numerous new lighthouses have been built. Amongst those round the British Isles in particularly difficult and dangerous positions may be mentioned the Wolf Rock, the Dhu Heartach, and the new Eddystone. The old lighthouse, built by Smeaton at the Eddystone, having been completed in 1759, withstood for 120 years the force of the waves, but the rock on which it stood being gradually undermined by the sea, showed its end to be approaching. A new tower, 58 feet higher, has been built on an adjoining rock, and the old tower removed. The old method of dovetailing the stones, invented by Smeaton, has been further developed, and in the modern towers the rings of stone are dovetailed together vertically as well as horizontally, and in addition each stone is further secured to the course below by a pair of metal bolts. The electric light was first used at the South Foreland in December, 1858. In 1862 it was applied to the Dungeness Lighthouse; the mean intensity of the light produced at the focus was then 670 candles, and the intensity of the beam was $12\frac{1}{2}$ times that of the old catoptric light.

At the two South Foreland lighthouses the substitution of the electric light, together with new dioptric apparatus in 1872, has increased the intensity of the beam from the upper light twenty times, and from the lower ninety times that of the old catoptric light previously in use. At the Lizard Point, the sperm oil Argand lamps were replaced in 1873 by Siemens electric lights and dynamos driven by caloric engines, the dearth of water rendering steam engines less suitable, and a siren fog signal is sounded in thick weather. The improvements here made are so great that the intensity of the beam has been increased 211 times, while, owing to the advance in electric machines, and the means of driving them, the cost per unit of light is one-ninth of that at Dungeness, and the quantity of light per lb. of fuel twenty times.

Amongst canal and river works successfully accomplished since 1862, the most important is beyond doubt the Suez Canal, which was opened for traffic in November, 1869.

Before the success of this great work was assured, numerous insuperable difficulties were anticipated by its opponents, but these have all been shown to be without foundation: thus it was stated by many persons that the evaporation from the surface of the Bitter Lakes, when water was admitted to them, would be so great that many years would be required to fill them, and that a strong current would always be maintained towards them, and that they would become completely choked up by a deposit of salt. But the entire space, containing 1,962,000,000 cubic yards, was filled from the canal between March 18 and October 24, 1869, and instead of a new deposit of salt taking place the old banks of salt were in six years dissolved away to the extent of 88,000,000 tons. Analyses of the water of the lakes showed that the saltiness of the water increased rapidly at first as the banks were dissolved, but each year it has diminished, showing that a constant interchange of water between the lakes and the seas takes place. Observations show that the north and north-west winds prevailing from May to October raise the mean level of the sea at Port Said and lower it at Suez, producing in September a difference of level of one foot four inches, and causing a current from the Mediterranean to the Red Sea. In the winter the direction of the current is reversed by the prevailing southerly winds. The importance of this work to the commerce of the world is shown by the following table of the traffic through the canal:—

	Number of Ships.			Net Tonnage.			Receipts.	
1870	486	...	...	436,609	...	...	£206,372
1877	1663	...	...	2,355,447	...	...	£1,810,973
1883	3307	...	...	5,775,861	...	...	£2,740,933

Another work of great importance is the Amsterdam Ship Canal, commenced in 1865 and opened in 1876, shortening the distance from Amsterdam to the North Sea from 52 miles by the old North Holland canal route, to $15\frac{1}{2}$ miles, and giving a depth of 23 feet for vessels in place of $18\frac{1}{2}$ feet. The works include a harbour in the North Sea 260 acres in extent, enclosed by two piers 5000 feet in length. The channel was dredged, and the material raised, being mixed with a sufficient quantity of water to reduce it to a semi-fluid state, was delivered on to the banks by

means of a Woodford pump and a line of wooden tubes floating on the water. Looks at the two ends of the canal and pumping machinery are provided in order to maintain the level of the water 1·29 meters below ordinary high water in the North Sea, to provide drainage for the low-lying lands.

The Panama Canal, now in course of construction, is a work of even greater magnitude and difficulty than either of the preceding. It is designed to provide a canal, $8\frac{1}{2}$ metres in depth, from the Atlantic to the Pacific. When completed it will be $45\frac{1}{2}$ miles in length, and is estimated to cost £31,200,000.

Improvements in the mouths of rivers have been year by year steadily carried on, notably in the Clyde, Tyne, Danube and Mississippi. On the latter river jetties two miles in length have been constructed of brushwood weighted with stones; these become gradually embedded in silt, and are further consolidated by stones on the surface, and covered by a capping of concrete blocks. By means of these jetties the current has been directed and accelerated and thus made to excavate and maintain for itself a deep channel through the river bar.

In works of water supply and sewerage most large towns and cities have had additional works constructed in order to provide an augmented supply. In the metropolis the intakes of some of the companies deriving their supply from the Thames, which had previously been removed to points above the tidal portion, have again been moved further upstream to escape local impurities. In the case of some large towns an entirely new supply has been provided, such, for instance, as Glasgow and Dublin. Works for a new supply for Liverpool from the head waters of the Vyrnwy are in progress; the water will be impounded by a masonry dam 84 feet high, forming a reservoir 1115 acres in extent. At Antwerp the supply for the whole city of 200,000 inhabitants, taken from the River Nethe, is filtered through sand and spongy iron on Bischof's system; in winter, to avoid the effects of severe frost, the water is warmed a few degrees by steam before entering the filters.

The most extensive work hitherto carried out in connection with town drainage has been the construction of the metropolitan intercepting and outfall sewers, in all 82 miles in length. These works involved the use of 318 million bricks, 880,000 cubic yards of concrete, $9\frac{1}{2}$ million yards of excavation, and the erection of pumping stations of 2380 horse-power collectively, the total cost of the whole being £4,100,000.

At Berlin, with a population of over a million, a complete system of sewerage has been commenced and brought into operation within the last few years. The whole area is divided into five districts, in each of which the sewage is collected by gravitation and pumped from a single station to land, on which it is disposed of by irrigation. The land is cultivated under grass and vegetables, and it is stated that no ill effects are traceable in the neighbourhood to the sewage discharge; the financial results of the cultivation show a loss.

The outfall sewer of Boston, U.S.A., is remarkable for the originality and boldness of the design, as well as for its successful accomplishment. The whole sewage of the city is pumped into an elevated tank sewer, 1200 feet in length, whence it passes through an inverted siphon for a length of 7000 feet, constructed in tunnel under the bay at a depth of 135 feet below low water to the land beyond. Then rising into an elevated sewer 5335 feet in length, built partly on the mainland and partly on embankment across the flats and channel, it passes into a reservoir, from which it is discharged into the sea on the ebb tide, when there is a strong current setting outwards.

Works of reclamation and drainage of land have been carried out on a large scale in France, notably in the Landes of Gascoyne and the plain of Forez. The Landes, nearly two million acres in extent, formerly uninhabited and desert, situated near Bordeaux, consist of a poor sandy soil overlying an impervious substratum. This and the level character of the ground rendered natural drainage impossible, and the water supplied by an abundant rainfall remained stagnant until dried up by the heat of summer. A complete system of drainage by artificial channels and canals, inaugurated in 1857, has reclaimed nearly the whole area; it is now planted as forest, estimated to be worth £10 per acre at the age of thirty years, £30 at seventy years, and the district is rendered habitable and one of the healthiest in France.

The drainage of Fucino, the largest lake in Central or Southern Italy, effected in 1869, is of historical interest. The lake was situated in a catchment of 173,000 acres, having no natural outlet; with variations in the rainfall and evaporation, it rose and inundated the country around,

or fell below its normal level, and spread disease by the exhalations from its shores. The drainage of the lake was suggested by Julius Cæsar, and was attempted by some of the Roman emperors, and by other sovereigns at a later date. The average dimensions of the lake were 12 miles long by 7 miles wide, containing 37,050 acres. The Emperor Claudius projected a tunnel to the river Liris, which was eventually completed; it was 6178 yards in length, but proved insufficient in size, and was choked up by an accident. In 1854 a new and larger tunnel, 19 feet by 30 feet, was commenced by Prince Alexander Torlonia, following the line of the Roman work, and was completed in 1869. In addition to the tunnel 6887 yards in length, 62 miles of canal, 130 miles of roads, and 402 miles of ditches were completed, reclaiming 35,012 acres of land, at a total cost of £1,800,000.

Under the class of land reclamation and embanking, the most important works in this country are the Thames Embankments within the metropolitan area. These great works, extending for a length of $3\frac{1}{4}$ miles, executed between the years 1860 and 1875, at a cost of a million and three quarters, have converted 52 acres of muddy foreshore into ornamental gardens, and provided at the same time the finest thoroughfare for traffic and the noblest embellishment the metropolis has received since the days of Sir Christopher Wren.

The increased economy necessitated by competition requires designs for all classes of construction to be cut finer year by year, and renders inevitable an accurate knowledge of the properties of the materials employed in order that either the best, or the best at the price, may be selected; thus machines for testing cement and other building materials, iron, steel, and other metals, have come into more general use. In the smaller machines the test load is applied by a movable weight acting through a system of levers; in the larger, chiefly used for the testing of metals, the load is put on by the hydraulic press. In the Emery Testing Machine at the U.S. Arsenal, Watertown, the most complete and powerful yet constructed, tension or compression up to 800,000 lbs. can be applied by a press 20 inches in diameter.

In military engineering and fortification the principal changes have been necessitated by the increased range and accuracy of modern rifled ordnance, and by the invention of machine guns. The increased range of guns requires the first line of defence of an important town to be placed much further out; the length of position to be occupied makes it impossible to man and arm a continuous line; and thus detached forts are made use of, as at Antwerp and Paris, and in the most modern works are placed at a greater distance from the citadel. Iron-plated forts or turrets are employed in positions liable to attack at close quarters, as at Spithead, Plymouth, and Dover pier, while, to narrow the embrasure and provide against splinters, iron shields are built into the granite forts of the Thames and Medway defences and elsewhere. Dynamite and gun-cotton mines, fired electrically, for defence or attack, captive balloons and electric search lights, for watching the movements of the enemy by day and night, are among the modern resources of the military engineer.

In the departments of building materials and construction, the advance is very marked in the artificial reproduction of natural substances such as marble and stone; fire-proof floors, constructed of iron joists embedded in concrete, and iron sliding doors in party walls are used as a precaution against the spread of fire in large buildings. Iron girders concealed in masonry take the place of the old timber beams or arches in the face walls of buildings, and the introduction of lifts enables houses to be carried to the greater height rendered almost inevitable by the increased cost of land in cities. Many improvements have been introduced into the machinery for the production of bricks and tiles, while wood-working machinery has largely superseded hand labour in the manufacture of every possible form in which this material is employed.

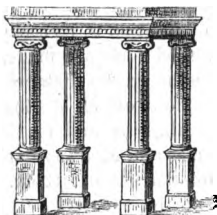
In the domain of house sanitation, including heating, ventilation, and drainage, true principles may now be considered fairly established, but their adoption in practice is too tardily advancing. It is not for want of variety in design or choice of appliances that unsanitary houses, smoky chimneys, draughty rooms, and ill-ventilated public buildings afford the choicest field for the sanitary reformer.

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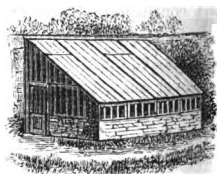
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See also Advertisement on page 32. . Group 3.

GROUP III. — ENGINEERING CONSTRUCTION AND ARCHITECTURE.

SOUTH GALLERY, NORTH COURT.

[For Railway Plant, see Group V.; for Launching Ships, see Group VII.; for Surveying Instruments, see Group XXVIII.]

211. SMITH, W. B., 14 Dale Street, Leamington; and 32 Ashchurch Grove, London, W.—(1) Improved Diagonal Cross-Bonding Bricks, specially adapted for ventilating and heating purposes, and for light and strong construction of buildings. (2) Improved methods of laying in courses of different thicknesses.

212. HALL, H., Architect, 19 Doughty Street, Mecklenburgh Square, London, W.C.—(1) Patent Hanging Tiles, intended for facing old or new walls or wood partitions, where extra light is required; they are damp-proof, fire-proof, and resist frost. They are glazed, white and all colours. (2) Glazed Bonding Bricks, effecting a great saving in the cost and giving increased reflection [Cliff's Patent].

213. SHARMAN, JOHN, 81 Liverpool Road, Islington, London, N.—Patent Brick and Tile Making Machine.

214. REDGRAVE, GILBERT R., Sunnyside, Muswell Hill, London, N.—(1) Patent Interlocking Kiln Linings. (2) Kilns constructed on a new principle.

215. THOMPSON, WM., Evesham Road, Stratford-on-Avon.—Improvements in constructing or building concrete foundations, walls, and blocks, and in frames, moulds, or apparatus employed therein. Walls may be constructed by this method in most cases at one-half the cost of brick or stone walls, and one-third less cost than solid concrete walls.

216. BROWNLEE & CO., City Saw Mills, Port Dundas, Glasgow.—Robb's Patent Improved mode of jointing or connecting tiles and wooden blocks to form roadways, parquetry floorings and panels, &c.

217. TEBBUTT, CHAS. GOODMAN, Bluntisham, St. Ives, Huntingdonshire.—Patent Safety Bricks for flooring stables, market places, railway loading pens, carriage and stable yards, and all places where a combination of perfect cleanliness, surface drainage, and safety of movement to animals is required.

218. CRESSY, BENJAMIN SEAMAN, 56 St. Mary's Terrace, Hastings.—Patent Hydraulic Freestone for architectural and building purposes.

219. FRANKENBERG, S., & CO., 31 Kennington Park Road, London,

S.E.; and Eagle Wharf, Camberwell, S.E.—(1) Mastic Asbitum for lining Fire-proof Floors. (2) An Improved Damp Course Compound. (3) Inodorous Leather Roofing Felt.

220. BRIGGS & CO., 58 Rokeby Street, Stratford, London, E.—Patent Apparatus for use in soldering and lead burning. Plumbers' fires or heated irons dispensed with, no spelter or acid required.

221. ELECTRIC PAINT REMOVER CO. (THE), Limited, 3 Westminster Chambers, Victoria Street, London, S.W.—Electric Paint Remover.

222. HUMPHERSON, F., 331 King's Road, Chelsea, London, S.W.—Flushing Cistern.

223. CLARK, WALTER, 14 Upper Westbourne, Aldington, Brighton.—Improved invention for casting ceilings, walls, and other large surfaces required to be plastered.

224. MUNICIPAL APPLIANCES CO., Limited, 37 Victoria Street, Liverpool.—(1) Gas Fired Lime Kiln. (2) Improved Water Meter. (3) Towns' Refuse Destructor, in which arrangements are provided for entirely removing the objectionable effluvia given off from the heaps of refuse before they are destroyed by fire.

225. JOY, WILLIAM, 40a Stonebridge Hill, Northfleet, Kent.—(1) Kilns for burning and drying cement and slurry. (2) Kilns for drying and burning lime, bricks, slurry, and cement.

226. TEMPLETOWN, VISCOUNT, Castle Upton, Templepatrick, Co. Antrim, Ireland; and 49 Charles Street, Berkeley Square, London, W.—Improvements in labourers' cottage accommodation. Two important advantages are obtained by the interior arrangements of this cottage. By the first, three separate sleeping rooms are acquired, four, indeed, by means of a curtain or screen in the loft room. For the second, by the hot closet. Labourers when wet can at once shift themselves, and hang up their wet clothes to dry without any steam arising in the kitchen.

227. TIGHE, CHARLES, 42 Lombard Street, London, E.C.—Door Handles.

228. MIDDLETON, WM., 308 Munton Road, New Kent Road, London, S.E.—Improved method in slating iron roofs.

229. WILSON, DAVID, Millwood House, Grays, Essex.—Apparatus for drying slurry, as used in the manufacture of Portland cement.

230. SHARE, G. W., & CO., 72 King William Street, London, E.C.—Improvements in the manufacture of tanks, cisterns, &c.

231. SUFFIELD & BROWN, James Street, Devonport Street, Commercial Road, London, E.—(1) Fresh Water Distilling Apparatus. Compound Fresh Water

Distiller specially for sailing ships for independent condensation of exhaust steam from donkey engine. (2) Surface Condenser for steam engines. (3) Cold Feed Water Heater for heating cold water.

232. SPOOR, J. L., Gateshead-on-Tyne.—Patent Machine for testing cement. This machine enables the tensile strain to be applied automatically and regularly, and the breaking-strain is self-registered.

233. GEARY & WALKER, 7 John Dalton Street, Manchester.—Patent Premier system of Wood Block Flooring. Proof against dry-rot and dampness. The blocks are laid in an adhesive and preservative composition, which, being forced into a V-shaped groove, secures them firmly in position. In addition to this a metal key is employed to fasten each block to the composition and the underlying cement bed, so that the blocks cannot possibly be loosened.

234. FOX, CHAS. JAMES, 2 Vernon Place, Conway Street, Birkenhead.—Sectional Docks for inspecting and repairing submarine portions of ships while afloat in dock or at anchor, without disturbance of cargo.

235. BIDDER, J., & LODGE, W. R., 38 Parliament Street, London, S.W.—Floating Breakwater [Patent]. For the construction of cheap or temporary shelters [harbours of refuge] for shipping, especially coasters, and fishing-vessels and yachts; for protecting piers and harbour works under construction, enclosing bathing places, foreshores, &c. Also in war to cover the landing of troops and material upon exposed coasts, being easily carried in the hold of a ship, and put together by the crew and artificers of any man-of-war or transport.

236. LAMPARD, STEPHEN, 63 St. George Square, Portsea; and 6 Tothill Street, Westminster, London, S.W.—(1) Improved Floating Bridge, working on chains. (2) Landing Stage and Connecting Gangway.

237. EDWARDS, GEORGE, Whitby Lodge, New Thornton Heath, Surrey.—(1) Improvements in tunnels, subways, and volute approaches, and in apparatus for constructing subways in the beds of rivers. (2) Improved system of metallic permanent way for railways [Vogdt's system].

238. BEAMISH, G. H. T., Spy Hill House, Queenstown, Ireland.—Improved Method of Construction with concrete or other blocks, suitable for breakwaters, groynes, wharf walls, &c., allowing of an uneven settlement in the base of structures, without injury to their general stability.

239. HAMAND, A. S., Palace Chambers, Bridge Street, Westminster, London, S.W.—(1) Floating Breakwater or Pier. (2) Improved Fish Plate.

240. IRVING, ALEX., REV., B.Sc., B.A., Wellington College, Wokingham.—Improved method of purifying water contaminated by dissolved vegetable matter.

241. STEEL, MAJOR EDWARD H., care of MESSRS W. WATSON & CO., 27 Leadenhall Street, London, E.C.—Automatic Bucket or Bag.

242. WASTE WATER METER CO., Limited, 32 Park Lane, Liverpool.—Differentiating Waste Water Meter [Deacon's Patents]. This instrument records the time and rate of flow through water mains, distinguishing water wasted from water used. It registers change of velocity during day and night, giving the means of ascertaining the most wasteful districts, thus enabling work to be carried on in the worst streets.

243. SIMONS, W., & CO., Renfrew.—Screw Hopper Dredgers and Elevating Steamers.

244. AMOS & SMITH, Albert Dock Works, Hull.—(1) Working model [small scale] of Excavator for use in the construction of railways or docks, or for any purpose where it is required to remove soil in large quantities. The system is also applicable to submarine dredging. (2) A working head of the same machine, full size.

245. RENNIE, G. B., 20 Lowndes Street, London, S.W.—Navigable and Self-propelling and Careening Floating Dock.

246. DOWSON, ALFRED, 8 Great Queen Street, Westminster, London, S.W.—Improvements in Groynes for the protection of foreshore. The leading feature of these groynes is that they are of open construction, so that shingle, &c., can be trapped and retained without impeding the free passage of the waves. They are more efficient, less costly, and less liable to damage than the ordinary solid groynes.

247. WILSON, ROBERT, 68 Fleet Street, London, E.C.—Improvements in lenses for pavement lights, deck lights, &c.

248. BRYCESON, JOHN, Charlton Works, Islington Green, London, N.—Continuous Blast Fog Horn, for use on ships, pier-heads, lighthouses, &c. Long or short blasts can be produced, so that a code can be signalled.

249. WISWALL, F., & COLLIER, W., Bridgwater House, Chester Road, Manchester.—Patent Tilting Weir.

250. HAMILTON, FORSYTH & CO., Mansion House Chambers, 11 Queen Victoria Street, London, E.C.—(1) Proposed Tower Bridge. (2) Tidal Sluices.

251. BRADSHAW, RICHARD, Old Swan Pottery, near Liverpool.—Bradshaw's Patent Brick-making Machines and Water Filters.

252. ROLAND & BARNES VULCAN MANUFACTURING CO., Rolfiffe Street, Islington, London, N.—Meters for water and other liquids, which will measure to the dripping of a tap [Barnes & Heath's Patent].

253. JOHNSON, WILLIAM, Cardigan Works, Leeds.—(1) Direct-acting Brick-making Machine. (2) Lever Steam Brick-pressing Machine. The two machines are designed to work in conjunction with each other, and produce perfectly-finished pointing bricks at a minimum of cost; adaptable for shale, stony material, and any other clays. Pressing machine can be used singly; $3\frac{1}{2}$ man-power Dunschop gas engine driving the above.

254. EASTON & ANDERSON, 3 Whitehall Place, London, S.W.; and Erith Iron Works, Erith, Kent.—Upward's Apparatus for boring and tapping water or gas mains, or other vessels under pressure, and for fitting or applying cocks or nipples.

255. DE MICHELE, V., 14 Delahay Street, Westminster, London, S.W.—Patent Automatic Standard Cement Testing Machine, for test on one square inch of 100 lbs. per second from 100 to 1000. The machine is adjustable to various speeds.

256. HASTINGS PATENT HYDRAULIC FREESTONE COMPANY, Limited, Earl Street, Hastings.—This Stone is not made with cement, but is a real stone identical in its constituent parts and durable and working qualities with the best quarried stone. It can be formed in any design and of any colour, and the price is much below that of ordinary stone.

257. RICHARDS, WM., 23 Romola Road, Norwood Road, London, S.E.—Models of Water Meters, of the positive class, that is, with pistons and cylinders.

258. JONES, T., 36 Sloans Street, London, S.W.—(1) Ventilator to admit fresh air by means of an ordinary grating placed in outer wall. It can be regulated to suit changes of temperature. (2) Ventilator placed in chimney breast, and by its syphon action removing from rooms, kitchens, offices, &c., burnt gas, tobacco smoke and other impurities; it is very serviceable where kitcheners and modern stoves are used.

259. TITUS, J. T., & CHAS. HINKS-MAN, 117 Great Russell Street, Bloomsbury, London, W.C.—(1) Patent Sewer and Gas Trap. (2) Tide and Flushing Gate.

260. LONDON WATER METER SUPPLY CO. (THE), 13 & 14 King Street, Cheapside, London, E.C.—(1) Tooth's Patent Rotary Meters. (2) Tooth's Railway Tank Meters. (3) Alexander and Tooth's Patent Automatic Feed Regulator. (4) Model of the Dausin Domestic Engine for

cleaning boots, knives, &c., driving sewing machines, pumping water, and other household appliances.

261. KENT, GEORGE, 199-201 High Holborn, London, W.C.—Patent Uniform Positive Water Meter.

262. SOUTH-EASTERN RAILWAY CO., AND SUBMARINE CONTINENTAL RAILWAY CO., London Bridge Station, S.E.—The Channel Tunnel. Models:—(1) Model of the bed of the sea in the Straits of Dover, showing the course of the proposed Submarine Tunnel and the geological formation along its centre line. (2) Model of the bed of the sea in the Straits of Dover, shewing the submarine chalk formation at right angles to the centre line of tunnel. (3) Model of Boring Machine constructed by Messrs. Beaumont & Co. for the experimental works of the Submarine Continental Railway Co. Cartoons:—(1) Map of the geological formation in the Straits of Dover, showing the course of the proposed Submarine Tunnel. (2) Longitudinal section of the proposed Submarine Tunnel, showing the bed of the sea and the geological formation along the centre line. (3) Cross sections of the geological formation taken at right angles to the centre line of tunnel.

263. BEAUMONT, E. C., & CO., 43 Imperial Buildings, Ludgate Circus, London, E.C.—Hydraulic Dredger.

264. BRABY, F., & CO., Limited, Fitzroy Works, Euston Road, London, N.W.—(1) Improvements in Roll Caps for sheet metal roofing. (2) Improvements in and relating to bending corrugated metal. (3) Improvements in the means of securing sheet metal roofing. (4) An Improved Sliding Stud for fastening zinc and other metal sheets, so as to allow for expansion and contraction. (5) Improvements relating to glazing and fixing glass without putty.

265. BERNARD, JULIAN, 137 Long Acre, London, W.C.—(1) Improvements in baths. (2) Improved Engine or Motor.

266. LINDSAY, W. H., & CO., 14 South Wharf, Paddington, London, W.—(1) Patent Steel Bridge Decking for railway or road bridges. (2) Wrought Malleable Sash Frames. (3) Reversible Stair Treads. (4) Fire-resisting Girder. (5) Fire-proof Flooring, rolled with mild steel. By its use much weight is saved on the foundations, no girders being necessary.

267. ORMEROD, EDWARD, West Drayton, Uxbridge, London, W.—Improved apparatus for the manufacture of paving slabs for side-walks and footpaths.

268. BANISTER, F. D., Engineer's Office, London, Brighton, and South Coast Railway, London Bridge Terminus, S.E.—(1) Newhaven Harbour and

Breakwater. Models and appliances. (2) Steam Hopper Barge for sinking bags of concrete of 100 tons. (3) Carey & Latham's Concrete Mixing Machine, as used at Newhaven.

269. **SISSONS & WHITE, Hedon Road, Hull.**—Telescope Steam Pile Driver.

270. **HUNTER & ENGLISH, 202 Bow Road, London, E.**—(1) Hunter's Patent Floating Crane for naval arsenals, dock-yards and general dock purposes. (2) Model of Self-propelling 50-ton Floating Crane for East and West India Dock Co.'s Tilbury extension. The crane is capable of lifting and swinging through a complete circle weights up to 50 tons. It will also be used for masting ships. This system of crane obviates the necessity of moving ships from their berths, and allows ordinary loading operations to be carried on while boilers, crank-shafts, or other heavy pieces of machinery are being removed or shipped.

271. **PATENT MYCENIAN MARBLE CO. (THE), 6 Bunhill Row, London, E.C.**—Patent Mycenian Marbles.

272. **CROFT STONE QUARRY & BRICK CO. (THE), Croft, near Leicester.**—(1) Plain Mouldings in Croft Adamant (2) Ornamental Mouldings and Medallions in Croft Adamant.

273. **WOODHOUSE, ALFRED, A.M.Inst.C.E., Bridgewater.**—Patent Ventilating and Sanitary Concrete Building Block.

274. **THOMAS, T. & SONS, Acme Hoist Works, Cardiff.**—Self-sustaining Lifts, Hoists, Elevators, Winches, and Cranes.

275. **TRY, THOMAS, 4 Poland Street, Oxford Street, London, W.**—Improved Folding Door for automatic and instantaneous opening.

276. **SIMPSON, W. B. & SONS, 100 St. Martin's Lane, London, W.C.**—Decorated Enamelled Iron for the permanent decoration of ceilings and walls.

277. **HOMAN, ERNEST, 17 Gracechurch Street, London, E.C.**—Improvements in the construction of fireproof floors, landings, and staircases, rendering same sound-proof, and reducing cost to that of the ordinary inflammable construction.

278. **WEST, FRANK & JAMES P., 12 Limes Grove, Lewisham, London, S.E.**—(1) Building Slabs [rectangular and hexagonal] for concrete construction, applied. (2) Portable Travelling Scaffold. (3) Improved Adjustable Crane. (4) Liquid Concrete Elevator. The three latter combined in one machine.

279. **HEATLEY & HUTCHINS, 24 Paternoster Square, London, E.C.**—Giant Improved Hoist and Safety Clutch.

280. **WRIGHT'S BOILER CO., Boiler Works, Airdrie, Scotland.**—Patent Endless Flame-impact-hot-water Boiler for heating.

281. **HEATH, CAPT. WILLIAM E., 178 Camden Road, London, N.W.**—Improvements in the method of securing and shoring up dangerous structures, constructing cradles for shipbuilding, and for other purposes, scaffolding, &c.

282. **EDWARDS, WILLIAM, Queen's Hotel, Queen's Road, Battersea, London, S.W.**—Improved Self-closing Door.

283. **ACKROYD, J. GLENFIELD, Sowerby Bridge.**—Improvements in weighting windows and sashes.

284. **FALTING, A. & CO., 134 City Road, London, E.C.**—Patent Screw Clips for fixing scaffold, &c.

285. **PERRY, H. H., 6 Friends Road, Croydon.**—Railway Chairs.

286. **WEBB, W., 17 Heath's Road, Twickenham.**—Webb's Automatic Tidal Weir. The object of this invention is to provide means whereby the water of tidal rivers is not allowed to wholly run away to waste, but to impound a sufficient quantity of water at all times between the tides, to allow the navigation of the river to go on both up and down at all times of the day. The tides or the flood waters are not obstructed, but can pass the automatic weir the same as if it did not exist.

287. **EMPSALL, SAMUEL, Clay Pits, Halifax.**—Improvements in apparatus for preventing accidents in hoists.

288. **MACLEOD, MALCOLM, 66 Deansgate, Manchester.**—(1) Improved method of laying asphalt for roadways, foot-paths, &c., so as to prevent fracturing, blistering, and giving better foothold for passengers and horses; also for watertight roofs, tanks, &c. (2) Sample of solid granitic concrete.

289. **ADAMS & BAKER, 21 Union Street, Borough, London, S.E.**—Improved Door Springs.

290. **CARTER, JOHN, 66 Beaufort Street, Chelsea, London, S.W.**—Improvements in Vertical Sliding Windows, without weights or boxes. They take out for cleaning, fasten securely against thieves, whether open or shut, and can be opened and shut at any height.

291. **BAKER, A., 14 Warwick Gardens, Kensington, W.**—Model of church, showing method of carrying the central tower.

292. **GROOMBRIDGE, CHARLES, Clifcotte, Oliver Road, Leyton, Essex.**—Improvements in raising and closing windows, sashes, panels, and shutters, more particularly applicable to the windows of railway and other carriages.

293. **BOWELL, MARTIN, Staplefield, near Crawley, Sussex.**—Racks for blinds, spring, adjustable and in various ways.

294. WILDEGOSE, F. ROBERT, 20 Cambridge Place, Paddington, London, W.—(1) Improved Screwdown and Safety Drop Sash Fastening. (2) Improvements in joints for flexible pipe hose, soft metal pipes or tubes and connections. (3) Safety Sash Ventilation Bolt.

295. POOLE, C. J., 38 Hampton Road, Forest Gate, Essex.—Patent Swing Doors.

296. WILLETT, SAMUEL, 4 Commercial Place, Herne Hill, Surrey.—Improved Safety Sash Fastener.

297. DREGHORN, GEORGE, Albert Cottage, Glebe Street, Inverness.—Metallic Bands for Venetian blinds.

298. GARDNER, ROBERT WILLIAM, 17 Warwick Crescent, Paddington, London, W.—Self-closing Window Fasteners, in which springs and levers are dispensed with, the simple operation of closing the window being relied on for securing a safe and automatic fastening of the sashes.

299. WADE, WILLIAM, 21 Woodhouse Cliff, Woodhouse Moor, Leeds.—Patent Self-adjusting and Burglar-proof Window Fasteners.

300. HARLING, E. H., 13 Brown Street, Bryanston Square, London, W.—Patent Reliance Window Fasteners.

301. PATENT SELF-FASTENING COAL PLATE CO., 2 Wynatt Street, London, E.C.—Self-fastening Coal Plate for cellar openings.

302. BEGLEY, WM. GEORGE, 6 St. John's Street, Essex Road, London, N.—Bishop's Patent Automatic Window Fastener.

303. KNIGHT, JOHN M., Vestry Hall, Bancroft Road, Mile End, London, E.—Disinfecting Apparatus to Sewer Ventilators.

304. NEWTON, JOHN, 97 The Chase, Clapham, London, S.W.—Dust Accumulator and Condenser. An improved method of and means for removing dust, together with any infectious matter from furniture and rooms.

305. GROVER, GEORGE, 29 Leeward Road, Highbury Park, late of 3 Hazelrigge Road, Clapham, London, S.W.—Locking Plate for securing nuts upon bolts, which is applicable to fish plates and all bolts where great vibration takes place, either on locomotives, marine or stationary engines.

306. TALBOT, R., & SONS, Magnolia Wharf, Strand-on-the-Green, Chiswick, Middlesex.—Floating Swimming Bath.

307. HARLOW, BENJAMIN, Macclesfield.—(1) Simplex Portable Shelving for warehouses, stores, shops, &c. (2) Improved Blind Roller.

308. BURLEY, WILLIAM, Tower Chambers, London Wall, London, E.C.—(1) Improvements for raising, lowering, and holding Venetian blinds, and attaching curtains and tightening curtain tapes to window sashes and frames. (2) Patent Cord Holdfasts and Simple Ratchet Muslin Blind Fittings.

309. BUCHAN, HUGH, 50 Oswald Street, Glasgow.—M'Taggart's Patent Window Roller and Mounting, for blinds.

310. TOBITT, THOMAS, 24 De Laune Street, Kennington Park, London, S.E.—Improvements in sliding window sashes. These sashes are simple in construction, have no beading to remove, and open at the bottom for cleaning or other purposes.

311. WARHURST, JOSEPH, 74 Denmark Road, Kilburn, London, N.W.—Improved Application to bottom of doors and casements, effectually excluding draughts, rain or dust.

312. PATENT WINDOW FITTINGS CO., Limited (THE), 8a Rumford Place, Liverpool.—Patent for opening, closing and fastening house, railway and carriage windows. Pulleys, sash-cords, and fasteners dispensed with. Sashes dust-tight, and will not rattle.

313. PARTRIDGE, JOHN, 29 City Road, London, E.C.—(1) Blind Check Action for Venetian blinds. (2) Improvements in window blind fittings. (3) Adjustable Bracket for roller blinds. (4) Artistic Shade Window Blinds, Partitions, Curtains and Ships' Sails.

314. HOWCROFT, FREDERICK, 14 Tavistock Row, Covent Garden, London, W.C.—Automatic Sash Holder for supporting window sashes without weights or pulleys.

315. BORN, GUSTAVUS, 22 Clarence Square, Brighton.—Patent Safety Lever Sash Fastener.

317. HARCOURT, E. W., M.P., Nuneham Park, Oxon.—The Nuneham Park Induced-current Improved Chimney Cowl, manufactured by L. Besley, Nuneham Courtenay, Oxford.

318. LORRAIN, J. G., 37 Brooke Street, Holborn, London, E.C.—Patent System of Ventilation.

319. HERBERT, FRANCIS, Ravenscourt Park, London, W.—The Treatment of Water-carried and other Sewage by electricity.

320. CLUTTERBUCK, WILLIAM, 12 Victoria Road, Kilburn, London, N.W.—Apparatus for ventilating tunnels subways, and similar places; it can also be applied to theatres, music halls, smoking rooms, or any large building.

321. WILLIAMS, H. A., 37 Gurney Road, Leytonstone Road, Stratford, Essex.—Improved Window Sash Fastener. The fastening can be fixed to any sash; either sash can remain open for ventilation any height required, and secure and closed in the ordinary way, it being self-fastening.

322. TURNER & CO., Brick, Tile, and Ridge Makers, Barrow Haven, near Hull, Lincolnshire.—(1) Patent Ornamental Ventilating Ridge Tile. (2) Patent Roll Ventilating Ridge Tile.

323. ACASTER PATENT RAIL JOINT CO., Limited (THE), Castle Court, Sheffield.—Improvements in rail joints for railways.

324. RANSOMES & RAPIER, 5 Westminster Chambers, Westminster, London, S.W.; and Waterside Works, Ipswich.—Pendulum Titan.

325. ADIE, PATRICK, Broadway Works, Westminster, London, S.W.—Cement Testing Machines.

326. FAIJA, HENRY, M.Inst.C.E., 4 Great Queen Street, Westminster, London, S.W.—(1) Cement Testing Plant: cement testing machine, cement gauger, briquette moulds and appliances. (2) Cement Manufacturing Plant: cement grinding-mill, cement slurry dresser. (3) Specimens of Concrete, hardened by Faija's process. (4) Samples of Cement and of Raw Materials, from which it may be produced. (5) Illustration of the Process of Manufacture.

327. SCOTT-MONCRIEFF, W. D., 4d Upper Baker Street, London, N.W.—Improved Apparatus for submarine exploration.

328. ASKHAM BROS. & WILSON, Limited, Yorkshire Steel and Engineering Works, and Crucible Steel Foundry, Sheffield.—(1) Patent Crucible Steel Automatic Points and Crossings for tramways. (2) Patent Heel Plates for tramway points. (3) Patent Automatic Coupling for tramway engine and cars. (4) Patent Tramcar Wheels, Corf Wheels, &c. (5) Large Show Case, containing samples of cast steel, &c.; also patent wheels, &c. (6) General Display of Miscellaneous Castings and Tramway Exhibits.

329. DOULTON & CO., Lambeth.—Building Construction.

330. BALFOUR & CO., Lane End Works, Longton, and Tamworth.—(1) Terra-cotta Ware and Decorations, Flower Pots, and Tiles for public buildings and private houses. (2) Hollow or Vacuum Bricks, for lightness of construction, durability, warmth, and proof against damp. (3) Electrical Battery Troughs and Cells. (4) Coal Gas, with residuals extracted. (5) Working Machinery for horticultural and other ware.

331. CLARK & TANDFIELD, Westminster Chambers, London, S.W.—(1) Hydraulic Lifts. (2) Differential Accumulator. (3) Compensating Hydraulic Ram and Presses. (4) Railway Train Lift. (5) Contractor's Lift for trucks, wagons, carts, &c. (6) Pumps. (7) Floating Docks. (8) Hydraulic Grid Dock. (9) Patent Slip. (10) Improvements in centring, blocking, and supporting vessels. (11) Gripping Camels for warping. (12) Method of constructing harbours, piers, and breakwaters.

332. MARCH, W., & CO., 39 St. Mark Lane, London, E.C.—Patent Road Sweeper and Elevator, for sweeping 1200 sq. feet of street per minute and filling any vehicle behind with it is drawn; or for loading a two and a-half ton wagon in four minutes.

333. PATENT NUT AND BOLT COMPANY, Limited (THE), London Works, near Birmingham.—(1) Rail Fastenings. (2) Telegraphic Ironwork. Bolts and Nuts, Wood Screws, Rivets, Washers, &c.

334. SCANTLEBURY, W., 15 Bridge Road, Lower Clapton, London, E.—A method of connecting broad and narrow gauge railways.

335. DANDY, WILLIAM H., Bridge Street, Driffield, Yorkshire.—Patent Hygeian Window Blinds.

336. GARBETT, EDWARD LAG, 3 Myddelton Square, London, E.C.—Improved mode of fire building.

337. STEEL, W. H., 116a Clapham Park Road, London, S.W.—Elevator Dinner Lifts.

338. GIBB, JAMES, & CO., 99 Fenchurch Street, London, E.C.—Twigg & Gibb's Patent Water Meter. Bauer's Patent Spanners. (3) Bauer's Patent Pipe Vices. (4) Improved Dudgeon Trench Expander. (5) Wicksteed's Patent Trench Bearer.

339. HANNAH, SAMUEL, Lower Kennington Lane, London, S.W.—Engineering Construction and Architectural Work.

340. WELMAN, JAMES, W Street, Poole, Dorsetshire.—(1) Improved Dredging Apparatus, consisting of centrifugal pump, with special features to fit it for pumping sand, gravel, &c., and a nozzle to break up hard ground. (2) Compound Rotary Steam Engine, suited for driving centrifugal pumps and launches.

341. FRERE, NESTOR, 21 St. Mark Lane, London, E.C.—Improvements in joints of metal for pipes conducting water and steam.

342. PONTON, ARCHIBALD CAMPBELL, Viewfield, Park, Dorsetshire.—Improvements in the pro-

manufacturing artificial stones and concrete to greatly reduce the quantity of silicate lime binding the sand and other aggregates.

343. **TAYLOR & NEATE, Medway Works, Rochester.**—(1) Patent Sifter, for sifting cement, lime, coprolite, and other powders. (2) Lock Nuts for fish plates and key fastener chairs.

344. **HOLDEN, JOHN, Scotland Road, Nelson, Lancashire.**—Models showing improvements in the permanent way railways or tramways.

345. **QUARMBY, J., 149 High Street, Oxford Road, Manchester.**—Improved Railway Chairs and Sleepers, with self-locking attachment and wedges for same.

346. **BRIDGEWATER, HENRY, Bedford, Herts.**—Railway Chair with Interlocking Key Jaw.

347. **SMITH, S. W., Pinley House, near Coventry.**—(1) Twin Railway Chair and Safety Screw Bolts and Keys for securing rails in their chairs. (2) Self-oiling Fish Bolts. (3) Self-locking Sash Fasteners, with Mutes to prevent shaking.

348. **ROSEHER, CHARLES HENRY, Fulham Park Gardens, Fulham, London, S.W.**—Patent Simplex Railway Chair.

349. **PICKERING, JONATHAN, Rope Works, Stockton-on-Tees.**—(1) Hoists and Hoists. (2) Pulley Blocks. (3) Hoists. (4) Hoisting Machinery. (5) Mechanical Movements.

350. **LEADBEATER, SAMUEL, Machine Maker, Morley, near Leeds.**—Improved Railway Chair, single and joint, dispensed with wooden keys and fish plates, nuts and bolts.

351. **THOMSON & BROWNING, Victoria Street, Westminster, London, S.W.**—Denham & Olphert's Patent Cast Plate Sleepers for railways.

352. **LAWSWORTH IRON CO., Ilkeston, near Nottingham.**—Improved Patent Railway Chair.

353. **CROASDELL, SAMUEL T., The View, Brigham, Carlisle.**—Improved Batchet Locking Nut for railway joints. This nut is self-contained, requiring no set-pins, or check-nuts; does not damage the rail, and is screwed home on its proper bearing.

354. **KEELING, FRANCIS, & R. W. Birkland Street, Bulwell, Nottingham.**—Permanent Railway Chairs.

355. **WITHEY, EDWARD, & CO., Merton Shipyard, West Hartlepool.**—Improved Tramway Crossing.

356. **HAMILTON - SMYTHE, Thur, Athlone, Ireland.**—Improved

method of fastening flat-bottomed railway rails to their sleepers. The rails may be secured by this method to their joint and middle sleepers only, and be merely spiked to the intermediate sleepers, providing these are grooved to the required inwards cant.

357. **WATSON, JOHN, I. C. Johnson & Co.'s Cement Works, Greenhithe-on-Thames & Gateshead-on-Tyne.**—(1) Chamber Kiln for drying and burning cement [Johnson's Patent], fitted with patent flues for hastening the burning, and cooling the kiln and chamber [Watson & Spoor's Patent]. (2) Appliances for preparing slurry in making cement, including wash-mill apparatus, flint extractor [Watson's Patent], roller, grinding and mixing machine [Johnson's Patent].

358. **URQUHART, ROBERT L., 81 Lauder Road, Edinburgh.**—Improvements in connection with the construction of tramways or railways.

359. **PRICE - WILLIAMS, RICHARD, 38 Parliament Street, London, S.W.**—Improvements in the permanent way of railways.

360. **SAUNDERS, HENRY JAMES, Rock Fawr, Tondur, near Bridgend, Glamorgan.**—Improvements in securing bolts in the joints of railway and tramway rails, and a clip lock for securing the keys in the rail chairs of the permanent way.

361. **BROWN, J. D., & CO., 49 Fenchurch Street, London, E.C.**—Improvements in portable railway roads.

362. **CORTEN, WILLIAM, 41 North Church Street, Sheffield.**—(1) Improvements in chairs or rail fasteners. (2) Improvements in fish plates for rails.

363. **HINDSON, WILLIAM, 3 Claremont Park, Gateshead-on-Tyne.**—Hindson's Self-locking Railway Chairs and Sleepers, dispensing with the use of fish plates and bolts, wood keys, and nails or spikes.

364. **PATENT CABLE TRAMWAYS CORPORATION, Limited, 2 Victoria Mansions, Westminster, London, S.W.**—Cable Tramways.

365. **HOLTHAM, EDMUND G., 5 Westminster Chambers, London, S.W.**—Metal longitudinal sleepers and fastenings for the permanent way of railways. Adapted to rails of any section, but specially designed for use with the bull-headed rail upon main lines carrying heavy traffic.

366. **ADLARD, A. E., 33 Guildford Road, London, S.W.**—Reversible and Self-adjusting Tramway Rail and Self-adjusting Railway Rail.

367. **COLEY - BROMFIELD, J., 49 Selborne Road, Hove, Brighton; and 5 Westminster Chambers, London,**

S.W.—Improvements in the construction of pavements and roadways where it is required to accommodate telegraph, telephone, and other wires, gas pipes, and the like [Banner's Patent].

368. DIXON, A. A., 24 Queen Victoria Street, London, E.C.—(1) Flexible Fish Plate for permanent way. (2) Injectors. (3) Safety Valves.

369. SIDGWICK & CO., 5 Godliman Street, St. Paul's, London, E.C.—Patent Orderly Bin Manufacturers.

370. POWELL, WM. BOOTH, 3 Tintern Street, Ferndale Road, Brixton, London, S.W.—Patent Improved Combined Mud Receiver and Hydraulic Lift.

371. MYERS, WM. H., 202 White-chapel Road, London, E.—Underground Plan for passing crowded thoroughfares, also Plan for regulating traffic of roads on surface, for the protection of passengers crossing, where underground plan is not available.

372. TAYLER, R. W., 17 Angel Hill, Bury St. Edmunds, Suffolk.—Road Sweeping and Cleansing Machine or Automatic Scavenger, for collecting dust, mud, and snow from roads, streets, and gutters, and delivering the same into any receptacle to which it may be attached.

373. CONRADI, HENRY, 18 Golden Square, London, W.—Improved Combined Safeguard and Rail Cleaner for tramways. The apparatus is applicable to engines and cars alike. The safeguard removes any person fallen on the ground without any injury, and prevents in all cases neither the person nor any part of the body, as legs, or arms, or hands, to come into contact with the wheel and being crushed or otherwise injured, even in cases of children of any age. The apparatus is lowered and lifted either directly or automatically—the rail cleaner fixed to engine or car keeps the groove clean, can be set to work or be lifted out of the groove according to the requirements of the service, and thus reduces the tractive power required of horses to $\frac{1}{3}$ of its normal conditions.

374. DUNSCOMBE, CLEMENT, M.A., M.Inst.C.E., City Engineer, Liverpool, W.—Lyer Patent Tramways.

375. BURHAM BRICK, LIME & CEMENT CO., Limited (THE), 7 Nicholas Lane, Lombard Street, London, E.C.—Porter's Patent Automatic Cement Testing Machines, designed with the view of not only being automatic but also that the strain to which the briquettes have to be submitted may be gradually increased without jerking or irregularity.

376. PARRY, WM., 12 Lower Street, Caellipa, Bangor.—Improvements in bricks for preventing wet from penetrating into the wall.

377. ROBSON, JAMES, 20 Lomb Street, Fitzroy Square, London, W.—Drip Tiles for weathering parapet walls and cornices.

378. SHELLEY & COMPANY, 4 William Edward Street, Birmingham.—Improved system of securing glass to roofs stations, baths, billiard rooms, winter gardens, &c.

379. SLATE DÉBRIS UTILIZATION COMPANY (THE), 5 Westminster Chambers, Victoria Street, London, S.W.—The treatment of slate débris for the manufacture of various commercial products, viz.:—Potash alum, Argilline for sewage precipitation, detergent for wool and silk scouring and general purposes, Fuller's earth, French chalk, base for pigment manufacture, Cambric cement.

380. COTTAM & COMPANY, Winsley Street, Oxford Street, London, W.—(1) A Model of a Loose Box and T Stalls, showing an improved system of fitting up stables, with Cottam's improved sanitary surface, gutter and traps, &c. (2) A Specimen of Cottam & Co.'s Iron Spiral Staircase, wrought iron sash and panels made on an improved method of construction.

381. WELCH, E. J. COWLING, Palace Chambers, St. Stephens, Westminster, London, S.W.—Apparatus for regulating and controlling the flow of water, &c.

382. PUTNEY, ALFRED, Bridge Place, Harrow Road, Paddington, London, W.—(4) Patent Pavodilos Solid Wood Flooring. (2) Ornamental Floor Borders, Dados, Wall and Ceiling Panels.

383. EDWARDS, GEORGE M., 54 Gresham Street, London, E.C.—Iron and Concrete Pipes, Cylinders, &c.

384. HALL, JOSEPH, Wharncleft Chambers, Bank Street, Sheffield.—Automatic White Washer, being an improved and labour-saving apparatus for cleansing and colour-washing ceilings.

385. WHITCOMBE, ARTHUR, A.R.I.B.A., 8 Titchfield Terrace, North Gate, Regent's Park, London, N.W.—Drawings of improved systems of drainage showing inventions for the utilising of waste waters and for effectual automatic flushing.

386. DILLON, JAMES, M. Inst. C.E., 36 Dawson Street, Dublin.—Patent Hydrographic Surveying and Sounding Apparatus. For the use of engineers, hydrographers and geologists [with or without the aid of electricity] when preparing plans, sections, charts and soundings of ground under water; also for the use of naval navigating and military officers when navigating or determining depths of soundings for ships, steamers, boats, &c., ascending or descending rivers or approaching sea shores under an enemy's fire, &c.

387. BAYLY, J. PITT, C.E., M.S.A., 18 Fulham Place, Paddington, London, W.—Improved Hoisting Apparatus, applicable to low level bridge, and fully illustrated in the design for the Tower Bridge.

388. FIDLER, T. CLAXTON, 13a Great George Street, Westminster, London, S.W.—(1) Drawing of proposed bridge over the St. Lawrence at Quebec; central span 1440 ft. (2) Improved Construction of suspension bridges and arched ribs of iron and steel, illustrated by design for a rigid suspension bridge over the Thames at the Tower, with spiral approach on the south side.

389. DE RANCE, CHARLES E., Geological Survey Office, Museum, Jermyn Street, London, S.W.—Swallow Well Draining and Spring Charging.

390. PAGE, G. GORDON, 26 Endsleigh Gardens, London, N.W.; & **NUNN, R.,** 50 Shaftesbury Road, London, N.—Safety Swimming Baths, in connection with promenade piers and landing stages, adjustable to any state of the tide. The apparatus, or safety cage, can be at once raised from the water when required.

391. THWAITE, B. H., C.E., & B. D. HEALEY, C.E., 37 Victoria Street, Liverpool.—Thwaite & Healey's System of removing sandbanks and other submarine obstacles to traffic, or flow of water, sewage, &c.: showing the application of the system for the removal of the Pluckington Bank, under the St. George's landing stage on the River Mersey; and also to the Manchester Ship Canal for keeping the bed of the canal clear from silt accumulation.

392. BELL, E. INGRESS, Horse Guards, Whitehall, London, S.W.—Model of one Pavilion of a Projected Military Hospital, designed for a particular site in a hot climate, by Major-General Sir Andrew Clarke, R.E., A.I.C.E., and E. Ingress Bell, Architect. [The model to be accompanied by one or more illustrative drawings.]

393. CHIPPERFIELD, R., 26a Sekforde Street, Clerkenwell Green, London, E.C.—Model Maker. — Models of different inventions. (See *Building erected by British Patent Glazing Company, Outside, South Promenade.*)

394. ANDERSON, G., & CO., Arbroath Foundry, Arbroath.—Steam Derrick Crane, with steel ropes instead of chains. (See *Outside, South Promenade.*)

395. BATHO, W. F., 9 Victoria Chambers, Westminster, London, S.W.—(1) Bruce & Batho's System of Excavating and Dredging. (2) The Batho System of Open Hearth Steel Melting Furnace. (See *Outside, South Promenade.*)

396. GEVEKE & CO., Amsterdam, Netherlands (Agents, KUNSTER & RI-

CARD, 11 Queen Victoria Street, London, E.C.)—Geveke's Patent Tramway System. (See *Outside, South Promenade.*)

397. GRAFTON & CO., 113 Cannon Street, London, E.C.—Portable Steam Crane, Tilbury pattern, of two tons capacity, fitted with Patent Slewing Gear and Frictional Roller Path. (See *Outside, South Promenade.*)

398. LEGRAND, A., 13 rue Terre du Prince, Mons, Belgium.—Metallic Sleepers for railroads and tramways. (See *Outside, South Promenade.*)

399. STOTHERT & PITT, Limited, Bath.—Wild's Patent Single-chain Dredger worked by Stothert and Pitt's Improved Horizontal Steam Crane. (See *Outside, South Promenade.*)

400. WILKES & CO., 17 Devonshire Square, Bishopsgate Street, London, E.C.—Norton's Patent Tramway Road Cleaner and Sander. (See *Outside, South Promenade.*)

401. WARNER, JOHN, & SONS, Crescent Foundry, Cripplegate, London, E.C.—(1) Harrison's Patent Fog Bell Buoy Apparatus. (2) Goslin and Stoker's Patent Bell Buoys and Beacons. (See *Outside, South Promenade.*)

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ATTWOOD & CO., Canal Head Foundry and Engineering Works, Ulverstone, Lancashire. (See *Group XI.*)

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BLACK, HAWTHORNE, & CO., Gateshead-on-Tyne. (See *Group V.*)

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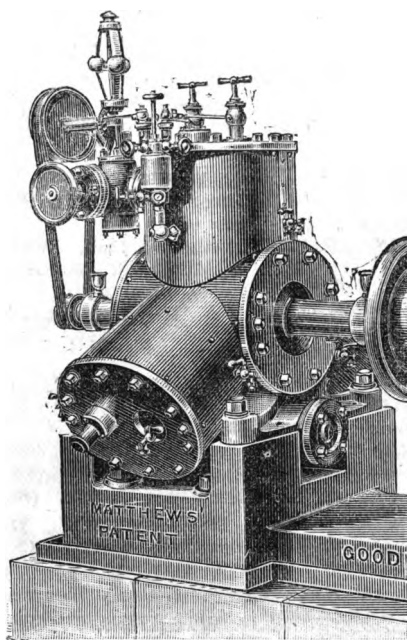
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PRIME MOVERS, AND MEANS OF DISTRIBUTING THEIR POWER.

BY WILLIAM ANDERSON, M.INST.C.E.

THE advances made during the last quarter of a century in heat engines has been almost entirely in the direction of improvements in details and in the recognition of the true principles upon which the conversion of heat into work is based. It is surprising how slowly the fundamental laws of Carnot, first enunciated in 1824, have been recognised even by those who have made heat engines a special study; and how frequently improvements have been introduced without a knowledge of the principles to which they are really due.

An illustration of this statement may be found in the rapid development of the compound engine during the last fifteen years. An immense economy of fuel has been achieved; yet, when the question is discussed and comparisons are instituted between the efficiency of single-cylinder and compound engines, the pressure of steam employed is either not considered at all or is but casually noticed, although, setting aside mechanical convenience and perfection of design and workmanship, the saving effected has been due solely to the increased initial temperature which necessarily accompanies increased steam pressure; for Carnot's doctrine, which is now established on an unassailable basis, lays it down that the efficiency of a heat engine is solely a function of the ratio which the range of temperature through which the engine works bears to the absolute initial temperature of the agent employed. To discuss the merits of two engines without reference to the temperatures between which they are respectively working, is as irrational as it would be to compare the efficiency of two water-wheels with reference to the weight of water used per horse-power only, without respect to the fall in each case. The method of working under a great range of expansion by the compound system is merely a convenient means of utilising a great fall of temperature,—there is no theoretical advantage inherent in it. In some of the latest treble-expansion marine engines working at 150 lbs. pressure, the fuel consumption has been reduced to 1·3 lbs. per indicated horse-power per hour, and nearly the same efficiency has been attained by gas engines. The extension of the compound system to locomotives and agricultural engines is of quite recent date, and as it has always been accompanied by an increase of steam pressure, the results have been satisfactory, not only in mechanical convenience, but in economy of fuel. In minor details much attention has been paid to the improvement of the governor and in arrangements for making it act directly on the grade of expansion; and valve motions, dependent on the movements of the connecting-rod, are increasing in favour on account of the saving of space which the suppression of the eccentrics secures.

Electric lighting and torpedo propulsion have stimulated the development of high-speed engines, and have turned attention once more to those of the rotatory class, among which the spherical engine, of quite recent invention, promises to become a practical success, and to remove the discredit which innumerable failures have impressed upon the whole order.

In steam boilers no real advance has been made, because advance was impossible, for the application of Carnot's doctrine shows that the limits of efficiency have long since been reached. Endless changes of form continue, indeed, to be introduced, but when the cardinal principles are attended to, one boiler is as good as another so far as its efficiency as a steam generator is concerned.

The main qualifications for excellence are:—a furnace sufficiently large to enable the chemical process of combustion to take place before the gases are allowed to cool below the temperature necessary for it, and, in view of promoting this condition, it has recently been proposed to keep the flame from touching the boiler plates altogether by means of brick rings placed at intervals in the flues; secondly, sufficient surface to absorb the heat from the products of combustion; thirdly, feed-water heating arrangements, worked at the lowest temperature, in the flues beyond the boiler; and lastly, artificial draught, so as to permit the temperature of the chimney to be reduced to a minimum. Forced blast has, lately, come very much into use in

torpedo craft and war vessels, but it has so far been employed only for the purpose of getting a large quantity of steam out of the boilers for exceptional service. The same system applied for the purpose of reducing the quantity of air entering the furnace, and for lowering the temperature of the chimney, will prove to be economical as well as convenient. The high pressures which are being gradually adopted in every class of boiler, and the large dimensions to which marine boilers have attained, have rendered it necessary to use material of the highest tenacity and ductility. Mild steel capable of resisting an ultimate strain of 30 tons per square inch, with an extension of 25 per cent. in 10 inches, is therefore rapidly superseding the use of iron in all parts exposed to tension, while the homogeneous nature of the material, due to the process of its manufacture, renders it peculiarly suitable for furnace work where plates are exposed to great and unequal heat.

In fuels, petroleum may be looked upon as a recent acquisition, since it is only lately that it has come into practical use, in some parts of the world, for locomotive, marine, and land boilers. Its full capabilities have not yet been developed, for the duty obtained is not commensurate with its high calorific properties. The direct use of petroleum in a species of gas engine has been attempted, but has not yet attained practical success; but the period represented by the Exhibition may claim the acquisition of the gas engine which is deservedly rising in favour for its economy in first cost, moderate space occupied, safety, and, it may be added, economy.

The conversion of heat into work by means of hot-air engines has made but little progress, and is confined entirely to machines of insignificant power, but a new departure has been taken in the attempt to utilise the latent heat of exhausted steam through the agency of the affinity of caustic soda for water. This promises to have some importance with respect to tramway and other short-journey engines.

In prime movers, adapted to utilise the natural forces of wind and water, but little has been done. Many varieties of windmills for small powers have been introduced chiefly for pumping; and in water motors the principal change to be noted is the increased favour with which turbines are regarded in this country. The stately water-wheels brought to such perfection by the late Sir William Fairbairn will soon be things of the past, and yield to the comparatively diminutive motor which performs its work silently, rapidly, and unseen.

Water-pressure engines have increased and multiplied, and have been fitted with arrangements for substituting low-pressure for high-pressure water, for a portion of the stroke, when full power is not required; and if with these be classed the whole array of single-acting motors which assume the shape of cranes and lifts, the progress made has been very great indeed, ranging in power from a 28-lb. dinner hoist to a lift raising a whole section of a canal with the craft floating thereon.

The transmission of power to great distances has occupied much attention, and has claimed as its agents—water, air, steam, ropes, and electricity.

The system of transmitting power by means of water under high pressure has settled down into a sort of routine practice, the pressure adopted, the very form of the pipes and fittings having taken a species of established type, but still some novelty has been introduced in the form of companies established for the purpose of laying mains and supplying water under high pressure throughout the streets of important towns, and thus saving the numerous small pumping establishments which are much more common than is generally supposed. An important rival, compressed air, has however arisen, and bids fair to obtain the supremacy. The extensive use of this agent in the great tunnel works throughout the world, the facility with which it can be applied to existing steam engines, the absence of mess from leakage, the ease with which the exhausted air can be got rid of, all commend it for general use. In H. M. Dockyard at Portsmouth, for example, where air has taken the place of water, great advantage is experienced in leading it on board the ships being fitted, and using it for working the various auxiliary engines without the necessity of keeping steam.

For the transmission of telegraph messages in large towns, from branch offices to the central station, pneumatic tubes are rendering most important service; and so convenient is the system that it is used even for the distribution of papers throughout the various rooms of large offices, where the circumstance of having air under pressure, or under a partial vacuum, at command, has given rise to the contrivance of many small labour-saving machines.

The great improvements that have been made in the quality and flexibility of wire-rope have

rendered them important agents in the transmission of motion to moderate distances, the percentage of power delivered being greater than either when air or water are used, and consequently great advantage is derived, especially in continuously running machinery. The best form and dimension of the pulleys have been ascertained, and all the particular difficulties connected with the various details have been overcome. The use of hemp or cotton rope and leather bands for distributing the power of the prime movers in factories to the several lines of shafting is extending very rapidly, and is said to yield considerable economic advantages—in first cost, in durability, and in economy of power—over the old arrangement of heavy slow-running shafting, the benefits being especially prominent in the case of machinery sent abroad, because freight is saved and less exactness is required both in the preparation and erection of the machinery. Electrical transmission of large powers to great distances is, no doubt, destined to receive great development, though at present it is scarcely possible to do more than mention the subtle agent which at this moment occupies probably a larger share of attention from the scientific world, as well as from the general public, than any other manifestation of force.

Upon the whole, a review of the progress made in the last quarter of a century in the machinery classed under Group IV. leaves the impression that, though nothing startling or even very novel has been achieved, yet in every branch there has been a great advance, due to the application of exact science to practical details, to the minor improvements which result from many minds contributing successively to the general good, and to the interchange of ideas and experiences which the numerous international exhibitions which have been held in various countries has tended to foster. The colleges devoted to scientific training in many of our provincial towns, and the numerous technical schools which have arisen, will infallibly leave their impression on the machinery produced in this country, and, by aiding the natural aptitude of the nation for mechanical construction, will enable it to hold its own in the keen competition now existing throughout the civilised world.

T H E
PATENT "VICTORIA STONE"
 IS
 LAID IN THE ENTRANCE HALL,
 CAFE, KITCHENS, AMERICAN BAR,
 AND
 THE TERRACE STEPS.

GOLD MEDAL, International Exhibition, Crystal Palace, 1884.
 DIPLOMA OF HONOUR, International Fisheries Exhibition, 1883.
 BRONZE MEDAL, Health Exhibition, 1884.

By Appointment to the Health Exhibition, 1884.

By Appointment to the Royal Agricultural Society.

The **ONLY MEDAL** for **ARTIFICIAL FLAGSTONE PAVING** at the
 International Health Exhibition, 1884.

This Paving is always laid in "flags" and never in a plastic condition.

The Stone has been used as paving to an enormous extent during the last eighteen years, equal in length to eighty miles, mostly for eighteen of the London Vestries and Boards of Works.

Its cost is 15 per cent. less than York stone, and its durability has been proved to be 33 per cent. greater.

It has two fair sides, and can be easily laid. Eighteen years' evidence of wear in London.

TENSILE STRAIN.—The average of 10 briquettes, *vide* "Reid on Concrete," was 794 lbs. per square inch in 1879, but has now reached 1,125 lbs. per square inch.

For Prices see Laxton and other Price Books.

ABSORPTION.—See "Wray on Stone." Bulk of water absorbed, as compared with bulk of stone per cent., 7-6.

THE PATENT VICTORIA STONE COMPANY,

Wharf: 283a, KINGSLAND ROAD.

Works: STRATFORD BRIDGE, ESSEX.

And at GROBY UARRIES, near LEICESTER.

GROUP IV.—PRIME MOVERS, AND MEANS OF DISTRI- BUTING THEIR POWER.

SOUTH GALLERY, MIDDLE COURT.

404. **RAMMELL, T. W.**, Reform Club, Pall Mall, London, S.W.—Pneumatic Railway [impulse system].

405. **SCOTT-MONCRIEFF, W. D.**, 4d Upper Baker Street, London, N.W.—(1) Combined Compressed Air Engines for tramway cars. (2) Steam Engine Governor.

406. **ALLIN, S. SEALY**, 52 Woodstock Road, Bedford Park, Chiswick, London, W.—(1) Water Motor constructed with endless chains, and balanced feathering floats adapted to the utilisation of river or tidal force. (2) Automatic Compensator for railway signals, absolutely without mechanism, working by the connection of metals of widely differing expansion and contraction to opposite ends of a correspondingly proportioned rock lever on signal post.

407. **MAUDSLAY, SONS, & FIELD**, Lambeth, London, S.E.—Model of Four Cylinder Compound Engines, as constructed for the vessels of the White Star Line and for the Compagnie Generale Transatlantique of France.

409. **CROSSLEY BROS.**, Limited, 24 Poultry, London, E.C.—(1) Otto Patent Gas Engines. (2) 7 Horse-power Single Cylinder Engine, with self starter. (3) 4 Horse-power Double Cylinder Engine. (4) $3\frac{1}{2}$ Horse-power Single Cylinder Engine. (5) $\frac{1}{2}$ Horse-power Vertical Engine. (6) 5 Man-power Vertical Engine.

410. **FAIRLIE ENGINE AND ROLLING STOCK CO. (THE)**, Palace Chambers, Victoria Street, Westminster, London, S.W.—(1) Double Bogie Locomotive. (2) Improved Iron or Steel Permanent Way. (3) Railways and Tramways.

HEPBURN, R. H., Palace Chambers, Victoria Street, Westminster, London, S.W.—(1) Railway Buffers. (2) Draw Cradles and Springs.

FAIRLIE, R. G., Palace Chambers, Victoria Street, London, S.W.—(1) Improved Iron and Steel Permanent Way. (2) Railways and Tramways.

413. **CLARKE & GILLESPIE**, Medowleat Works, Stevenage.—The Syrxin 2 Man-power Gas Engine.

414. **JEFFERY & BLACKSTONE**, Rutland Iron Works, Stamford, Lincolnshire.—Viator Portable Vertical Steam Engines on two high wheels.

415. **ADAMSON, DANIEL & CO.**, Engineering Works, Dukinfield, near Manchester.—(1) The Wheelock Automatic Cut-off Engine; designed to give regulation and economy of fuel. (2) Testing Machine, 100 tons, for obtaining tensile and other tests of metals.

416. **COALBROOKDALE CO.**, Limited, Coalbrookdale Iron Works, Shropshire.—(1) Parker & Weston's Patent Steam Pump [direct acting]. (2) No. 5 Coalbrookdale Engine. (3) Elwell & Parker's Patent High Speed Engine. (5) Vertical Pumps.

417. **GREENWOOD & BATLEY**, Albion Works, Leeds.—Improved High Speed Horizontal Steam Engine, with Patent Automatic Cut-off Regulator [Armington & Sims' Patent].

418. **WOOD, JOHN & EDWARD**, Victoria Foundry, Bolton.—Patent Corliss Engine.

419. **MARSHALL, J. T., & CO.**, Limited, Nottingham Engineering Works, Sandiacre, near Nottingham.—12-H.P. Compound Semi-fixed Engine and Boiler.

420. **HORNSBY, RICHARD, & SONS**, Limited, Spittlegate Iron Works, Grantham.—16-H.P. Patent Horizontal Undertype Compound Steam Engine, fitted with automatic expansion gear, and with boiler of special steel, each plate of which has been annealed.

421. **HATHORN & CO.**, 22 Charing Cross, London, S.W.—Patent Excelsior Locomotive Engine.

422. **OGDEN, RALPH**, Dean Street Iron Works, Ashton-under-Lyne, Lancashire.—The Manchester Automatic Expansive Steam Engine.

423. **HEENAN & FROUDE**, Newton Heath Iron Works, Manchester.—Tower Spherical High Speed Engine.

424. **WALKER BROS.**, Pagefield Iron Works, Wigan.—Air-compressing Machinery.

425. **WYNNE, FRANK**, 4 Carteret Street, Queen Anne's Gate, London, S.W.—Multiple Cylinder Silent High Speed Direct Acting Engine.

426. **CHAPMAN & REED**, Victor Engineering Works, Victor Road, Holloway, London, N.—Improvements in Engines worked by fluid pressure.

427. HARRISON PATENT STEERING ENGINE CO., Limited (THE), Ocean Works, Salford, Manchester.—Noiseless Steering Engines, for steam alone, or hand and steam combined.

428. DAVIS & CO., Limited, 25 Old Jewry, London, E.C.—(1) Davis' Patent Steering Gear. (2) Windlass and Capstan.

429. ANDREW, J. E. H., & CO., Stockport; and **80 Queen Victoria Street, London, E.C.**—(1) The Bisschop Patent Gas Engine for small powers. (2) The Stockport Patent Gas Engine.

430. DURHAM, CHURCHILL, & CO., 23 Leadenhall Street, London, E.C.—(1) Velometers and Marine Engine Governors. (2) Compound Attachments for controlling low pressure cylinders. (3) Sonnebulars, or Fog Whistle Operators. (4) Compound Spiral Metallic Piston Packing, for engines, pumps, &c.

431. BRABY, JAMES, Maybanks, Rudgwick, Sussex.—A Light Traction and Stationary Steam Engine combined; weighs 34 cwt., is of 3 horse-power nominal, capable of much higher power, is entirely under the control of one person, would be found of great service for transport and stationary work at manufactories, plantations, docks, &c.

432. DUNCAN BROTHERS, Engineers, 32 Queen Victoria Street, London, E.C.—(1) Improvements in Marine Engines. (2) Robert Duncan's Patent Engines, with steam cylinders $4\frac{1}{2}$ in. and 8 in. diam. by 6 in. stroke. (3) Bremme's Patent Engines, with steam cylinders 6 in. and 12 in. diam. by 8 in. stroke.

433. ROBEY & CO., Globe Works, Lincoln.—(1) Semi-fixed Compound Engine specially adapted for electric lighting, and fitted with Richardson's Patent Electric Regulator for maintaining either a constant current or constant electro motive force, irrespective of variations in boiler pressure or work done. (2) 12 Horse-power Horizontal Fixed Engine, fitted with Proell Corliss apparatus, forming complete automatic expansion gear, giving a range of cut off from $\frac{1}{4}$ to $\frac{1}{8}$ of the stroke, and securing the most economical distribution of steam.

434. KIRKSTALL FORGE CO. (THE), Leeds.—Improvements in Shafting, Coupling, and Bearings. The shafting is rolled so straight, round, and true, that it does not require turning; 20 per cent. increase in torsional strength and 33 per cent. increase in flexional strength. The couplings are held by friction. No keys are required. The bearings are adjustable.

435. LANE, HOWARD, & CO., 115 & 116 Palmerston Buildings, Old Broad Street, London, E.C.—Lane's Patent Sectional Steam Boiler, fitted with Lane's apparatus for illuminating interior of boilers by electricity, and observing action when working.

436. GALLOWAY, W. & J., & SONS, Knott Mill Iron Works, Manchester.—(1) Improved Galloway Steam Boiler. (2) Improved High and Low Pressure Compound Engine, with steam cylinders side by side. (3) Improved High and Low Pressure Compound Engine, with superposed cylinders. (4) Improved High Speed Parabolic Governor.

437. BRITANNIA COMPANY, Colchester.—(1) Three Hot Air Motors of small power. (2) Circular Saw. (3) Lathe and Fret Saw.

438. VENETIAN AIR VALVE FURNACE BAR CO. (THE), 36 Walbrook, London, E.C.—Galley's Patent Moveable Angled Feather Furnace Fire Bars, and Galley's Patent Tractorium.

439. WILSON ENGINEERING CO., 227 High Holborn, W.C.—Water Motor.

440. BAILEY, W. H., & CO., Albion Works, Salford, Manchester.—(1) Bailey's Patent Hot-air Engine for pumping purposes, arranged for working by gas jet; usual method of working is by a small coal or coke fire; gas jet used in this case for convenience of exhibition. (2) Drawing of Slow Combustion Hot-air Engine [Bailey's Patent].

441. FOX, SAMSON, C.E., The Leeds Forge, Leeds.—(1) Fox's Patent Corrugated Furnace Flues for steam boilers. (2) Corrugating Rolling Mill for the manufacture of corrugated tubes and plates.

442. PATENT STEAM-BOILER CO. (THE), & CONRAD KNAP, 11 Queen Victoria Street, London, E.C.—(1) Root's New Steam Boiler. (2) Stollwerk's Feedwater Purifier. (3) Knap's Mechanical Stoker and Furnace.

443. HODGKINSON & CO., Limited, Ordsal Machine Works, Woden Street, Salford, Manchester.—Hodgkinson's Patent Mechanical Stoker and Fire Bars for feeding steam boiler and other furnaces automatically. (See Group XVI., Class 89.)

444. PERKINS, A. M., & SONS, Seaford Street, Gray's Inn Road, London, W.C.—(1) Stationary High Pressure Engine and Boiler and Evaporative Surface Condenser. (2) Patent Metal Piston Rings.

445. STERNE, L., & CO., Limited, The Crown Iron Works, Glasgow.—(1) Clerk's Patent Gas Engine and Self-starting Gear. (2) Frictional Clutch Pulley and Coupling. (3) Boiler Flues, Iron and Steel Drums. (4) Arguzoid. (5) Sterne's Patent, Volute Springs. (6) Stevens' Improved Rubber Springs.

446. BRITISH GAS ENGINE & ENGINEERING CO., Limited (THE), 11 Queen Victoria Street, London, E.C.—(1) Atkinson's Improvements in Gas Engines. (2) Atkinson's Patent Feed Water Heater. (3) Improvements in Steam Pumping Engines. (4) Improvements in Surface Condensers and Tubes for same.

447. EDWARDS & CO., 35 Southampton Buildings, Chancery Lane, London, W.C.—Improvements in Gas Engines.

448. DEAKIN, PARKER, & CO., Sandon Works, Salford, Manchester.—(1) The Acme High Speed Governor [Lindley's Patent], in sizes from $\frac{3}{4}$ in. to 5 in. steam pipe, and fitted to a vertical compound tandem electric light engine, and also to an 8 h.p. new and improved self-contained engine. (2) Small Measuring Machine. (3) Model of Lindley's Patent Driving Gear for dynamos. (4) Vertical Engine with patent Acme governor and Raworth's system of friction driving gear for dynamos. [In motion.]

449. ROBERTSON, D. F. W., 31 Lombard Street, E.C.—Vertical and Horizontal Steam Engines.

450. GRIFFIN, SAMUEL, Kingston Iron Works, Bath.—Double-acting Gas Motor Engine.

451. SHANKS, A., & SON, Dens Iron Works, Arbroath; & 27 Leadenhall Street, London, E.C.—Inverted Cylinder Compound Surface Condensing Marine Engine.

452. BEYNON & COX, Torbay Iron Works, Torquay.—(1) Wither's Patent Gas Engine. (2) Cox's Patent Lever Gas Regulator.

453. KORTING BROS., 11 Pancras Lane, Queen Street, London, E.C.—(1) Patent Gas Engine. (2) Patent Universal Injectors. (3) Patent Self-acting Lubricators. (4) Patent Heating Elements.

454. MUMFORD, A. G., Culver Street Iron Works, Colchester.—(1) Steam Donkey Pumps. (2) Marine Engines, &c.

455. MCGILLIVRAY, JOHN, 24 Richmond Street, Glasgow.—Gas Engine.

456. ROGERS, R., & CO., Colchester.—Steam Steering Gear.

457. SKENE, ROBERT, 9 Wickham Street, Tyers Street, Lambeth, London, S.E.—Gas Engines, with improved self-lubricating pistons and other improvements.

458. HINDLEY, E. L., 11 Queen Victoria Street, London, E.C.—Collection of Steam Engines and Boilers of new design, specially adapted for domestic, industrial, and agricultural purposes.

459. WILLANS & ROBINSON, Ferry Works, Thames Ditton, Surrey.—(1) Willans' Patent Compound Engines for electric lighting and other purposes. (2) Electric Governor. (3) Vertical Boiler. (4) Fan Draught to quicken combustion in furnaces.

460. KITSON & CO., Airedale Foundry, Leeds.—Parson's Patent High Speed Engine, for driving dynamo-electric machines, ventilating fans, and centrifugal pumps.

461. NICHOLSON, W. N., & SON, Trent Ironworks, Newark.—(1) Portable Universal Steam Engine. (2) Small Vertical Steam Engines. (3) Specimens of the Patent Absolute Safety Valves, suitable for land, marine, and locomotive engines.

462. SMITH, SYDNEY, & SONS, Basford Brass Works, Nottingham.—(1) Improvements in Steam Whistles employed as danger signals, fog alarms, and for indicating the course of ships by characteristic sounds. (2) Improvements in Steam Valves and Taps. (3) Safety Valves. (4) Hydraulic Pressure Gauges.

463. MURRAY, JAMES, 8 Brown Street, Glasgow.—(1) Patent Metallic Packing for piston rods, valves, spindles, and pumps. (2) Patent Boiler Tube Scraper and Brushes and Brush Holder. (3) Improved Sight Lubricator with internal [removable] sieve for straining the oil.

464. PIDGEON, A., Engineer, High Street, Galley Hill, Swanscombe, Kent.—Model of Horizontal Engine with automatic expansion slide valve.

465. YOUNG, JOHN, 8 Union Court, Old Broad Street, London, E.C.—(1) Portable Form for indicating instantaneously, on application to a rotating shaft, the number of revolutions per minute the shaft is making. (2) Indicators for permanent attachment to indicate any speed from the lowest to the highest attainable.

466. SCOTT, FRANK WALTER, 44 Christian Street, Commercial Road, London, E.—Air Compressor.

467. MUNDEN, WILLIAM JOHN, 17 Sutton Street, York Road, Lambeth, London, S.E.—Improvements in Gas-motor Engines. This is a purely automatic engine, a simple and inexpensive flap-valve being substituted for the usual complicated slide-valve and eccentric, or cam.

468. SHARP & CO., 11 Holborn Circus, London, E.C.—Utilization of natural forces in relation to water, electricity, movements of the atmosphere, gases of various densities, &c.

469. HEMMINGWAY, I. JOHN, Dixon Street, Penistone Road, Sheffield.—Improvements in compensating metallic packings for piston rods, valve spindles, hydraulic rams, and other similar purposes. Applicable to the rods of steam hammers, blast engines, steam pumps, &c.

470. HAYES, J., C.E., 27 Leadenhall Street, London, E.C.—Models and Diagrams of the Automatic Boiler Feeder [Fromentin's Patent], for all kinds of stationary boilers.

471. RICHARDS, GEORGE, & CO., 23 & 24 Whitecross Street, London, E.C.; Works: Broadheath, Manchester.—Medart's Patent Pulleys.

472. STANFORD, WALTER H. C., 3 Westminster Chambers, Westminster, London, S.W.—Stanford's Patent Friction Clutch.

473. GIBB, JAMES, & CO., 99-100 Fenchurch Street, London, E.C.—T. H. Perrott's Patent Adjustable Belt Fastener.

474. SOUTHWELL, ALFRED, 5 Union Road, Northam, Southampton.—Steam Boiler Cylinder and Steam Pipe Composition Felt, for all kinds of stationary, portable, locomotive, and boilers of steamships, yacht launches, &c., with a saving of 10 per cent. of fuel, and reducing heat in stoke-holes 50°, also all kinds of hot-water bath pipes and brewers' liquor pipes; it requires no bands or external covering.

475. RITCHIE, JOHN (care of DUNCAN BROTHERS, 32 Queen Victoria Street, London, E.C.).—Patent Turbines.

476. MELLING, THOMAS (care of DUNCAN BROTHERS, 32 Queen Victoria Street, London, E.C.).—(1) Patent Water Motor. (2) Patent Water Meter.

477. MARSHALL & THURDER, 121 Fenchurch Street, London, E.C. (Agents, C. ATKINS & NISBET, 1 Water Lane, Great Tower Street, London, E.C.).—Automatic Metallic Spring Packing for stuffing boxes.

478. SCOTT, ERNEST, Close Engine Works, Newcastle-on-Tyne.—Ashton's Positive Actioned Power Meter and Continuous Indicator, which, without the uncertain action of frictional adhesion between wheels having no slide across each other at the same time that motion has to be communicated from one to the other, registers the actual amount of work done by an engine, thus ensuring accurate records.

479. JENKIN, FLEEMING, 3 Great Stuart Street, Edinburgh.—Nest Gearing. A system of gearing by which power is transmitted by rolling friction between drums so arranged as to bring no pressure on any bearing. Applicable to parallel shafting, right-angled shafting, oblique shafting, or coaxial shafting.

480. EWING, JAMES ALFRED, Professor of Engineering, University College, Dundee.—Friction Gear, suitable for driving dynamos, fans, and other pieces requiring a high speed. The gear forms a multiplying coupling between the shaft of the motor and that of the dynamo or fan.

481. HALL, J. & E., Dartford Iron Works, Kent; and 23 St. Swithin's Lane, London, E.C.—Compound Arm Pulleys.

482. HANSON, SCOTT, & CO., Stockport.—Driving Ropes.

483. PICHLER, S. FRANCIS, 162 Great Portland Street, London, W.—Motor Regulator, or means of transmitting power without band, pulleys, or clutch.

484. PATENT POWER PULLEY CO. (THE), 21 Arcade Chambers, St. Mary's Gate, Manchester.—Improvements in Pulleys and Drums, for main driving shafts, counter shafters, and for machinery of every description.

485. MACBETH, NORMAN, Victoria Foundry, Bolton.—(1) Macbeth's Patent Wrought Iron Belt Pulleys, with steel rims. (2) Improved Rope Driving Pulleys, with wrought iron arms.

486. MACKIE, J. & J., & CO., Engineers, Berks Iron Works, Reading.—Mackie's Patent Wrought Iron Spring Pulley.

487. LEE, JAMES, & SONS, Hipperholme Tannery, near Halifax.—Improvements in leather belting for driving purposes.

488. COBBETT, W. WILLSON, 82 Southwark Street, London, S.E.—Scandinavia Patent Cotton Machine Belting.

489. FLEMING, THOMAS, SON, & CO., West Grove Mill, Halifax.—Patent Square Leather Link Belting.

490. GANDY, MAURICE, 180 Queen Victoria Street, London, E.C.—Gandy's Patent American Cotton Belting, thoroughly waterproof, not affected by temperature, works well crossed, clings well to the pulleys.

491. KEENAN, MATTHEW, Armagh Works, Tredegar Road, Bow, London, E.—Patent Covering for coating boilers and steam pipes, combined together with air-chamber.

492. HARMAN, H. J., 100 King Street, Manchester.—The Lancashire Fusible Plug, with anti-scale tube [Harman's Patents], for the prevention of boiler explosions, and collapse of furnaces and flues, arising from deficiency of water in the boiler.

493. STOPES, ARTHUR O., Eagle Brewery, Colchester, Essex.—Improved Patent Apparatus for removing soot daily from the plates of steam boilers exposed to the action of the fire in the flues, thereby effecting great economy in the consumption of fuel.

494. JACKSON, J., 8 Frederick Place, Frederick Street, Gray's Inn Road, London, W.C.—Improved Gauges.

495. LEROY, F., & CO., Gray Street, Commercial Road, London, E.—(1) A Small Boiler covered with Leroy's Patent Non-conducting Composition for retaining heat, preventing condensation, increasing the power of steam, and saving fuel. (2) Sample of our Special Light Composition, requiring only one inch thickness.

496. WALTON, WILLIAM, & GEORGE T. IRVING, Murton House, Bishopwearmouth, Sunderland.—Invention for utilising tides and streams in the production of motive power, to be applied to the driving of machinery or the performing of work usually effected by steam engines.

497. RICHTER PATENT ECONOMISER MANUFACTURING CO. (THE), West End Mills, Longside Lane, Bradford.—Improvements in vessels for holding oils and other liquids, pumps, lubricating oilcans, and fire extinguishing apparatus.

498. GREENE, HENRY, & CO., 218 Upper Thames Street, London, E.C.—(1) The Patent Grip Belt Fasteners. (2) Improvements in Belt Fasteners.

499. NELSON, HORATIO, 90 Worship Street, London, E.C.—Mechanical Boiler Cleaner.

500. WHITTLE, WILLIAM, Holly Cottage, Cooper's Lane, Smethwick, near Birmingham.—Improved Circulating Steam Boiler.

501. TURNER, W. 'S., 68 Camden Street, East Street, Walworth, London, S.E.—Tube Scraper for Boiler Tubes, with spring between scraping cups.

502. LEITCH, GEORGE THOMPSON, 235 Hospital Street, & 41 Robertson Street, Glasgow.—Leitch's Rotary Steam Expanding Engine.

503. TULLY, W., & CO., 128 Queen Victoria Street, London, E.C.—Tully's Patent Tube Fastener.

504. MORLEY, SAMUEL, 27 Lorne Street, Stockton-on-Tees (care of WHITTAKER BROTHERS, Horsforth, near Leeds).—(1) Patent Needle Water Gauge. (2) Patent Automatic Manual Water Gauge.

505. GALES, W. H., 56 High Street, Poplar, London, E.—An Improved Tube Brush and Scraper combined.

506. MORGAN, D. J., Central Engineering and Ship Repairing Works, Cardiff.—(1) Tube Leak Repairing and Expanding Apparatus. (2) Safety Tube Stopper.

507. CAMBPELL, SIR A. C. (of Blythwood) & W. T. GOOLDEN, 2 Victoria Mansions, London, S.W.—Blythwood Speed Indicator.

508. BLACK, JAMES, Northgate, Peebles, N.B.—Revolving Cylinder Steam Engine.

509. CANNELL, CHARLES, Thorpe Asylum, Norwich.—Cannell's Electric Governor for steam engines in general.

511. KNOEFFERL, F., 100 Bolsover Street, Portland Place, London, W.—Improvements in Hot Air Engines.

512. COCHRAN & CO., Patent Boiler Manufactory, Birkenhead.—(1) Vertical Steam Boiler, with horizontal flue tubes, combining extra facility for cleaning, with economy of fuel and space. (2) Vertical Cylindrical Steam Boiler, with horizontal furnaces and ordinary flue tubes, offering every facility for cleaning, and economy of fuel and space.

513. FREEMAN, WILLIAM S., The Mills, Otford, Kent.—Duplex Water Gauge [Sight and Electric Alarm] for ordinary and very high pressure.

514. BULLOUGH, C. T., 6 Meads Row, Lambeth, London, S.E.—An Equilibrium Safety Valve, and an Automatic Resistance Governor.

515. CROOK, THOMAS, Borough Brass Works, Preston.—Automatic Water Gauges for steam boilers.

516. STEIN, WILLIAM, 17 Great Winchester Street, London, E.C.—White's Patent Self-acting Apparatus for regulating the supply of water into steam boilers, for preventing explosions.

517. TRIER BROS., 19 Great George Street, Westminster, London, S.W.—(1) Stauffer's Patent Lubricators and Lubricant for machinery. (2) Mechanism for obtaining step-by-step rotary motion, &c., as applied to numerical counters for machinery, gas and water meters, &c.

518. FLATHER, CHARLES J., 109 Portland Street, Southport.—A Method of removing incrustation from pipes, boilers, tanks, and similar vessels.

519. MAYHEW'S PATENT BOILER FEEDER CO. (THE), 2 Westminster Chambers, London, S.W.—Automatic Boiler Feeders, by which the water is maintained at a constant level at any pressure, and without the slightest attention.

520. DUCHAMPS, E. G., C.E., 14 Croxted Road, West Dulwich.—Dynamometer, and steam or other engine governors.

521. SCHÄFFER & BUDENBURG, 1 Southgate, St. Mary Street, Manchester.—(1) Improvements in Steam Pressure and Hydraulic Gauges. (2) Improvements in Steam Engine Governors and Automatic Steam Regulators. (3) Improvements in Steam Engine Indicators. (4) Improvements in Dynamometers and Tachometers. (5) Improvements in Engine Counters and other Speed Indicators. (6) Improvements in Injectors and other boiler feeders. (7) Improvements in Pyrometers and Thermometers.

522. UNDERWOOD, H. G., 13 Lee Terrace, London Road, Chelmsford.—Automatic Pendulum Governor for steam engines.

523. GRAY, I. W., & SON, 115 Leadenhall Street, London, E.C.—Gale's Patent Automatic Furnace Door, by the use of which ten per cent. of fuel is saved and almost total absence of smoke. It can be applied without alteration or stoppage of machinery.

524. HARTLEY & ARMOUX BROTHERS, California Engineering Works, Stoke-on-Trent.—(1) Vertical Boiler [Hartley's Patent], for tramways, yachts,

or general purposes. (2) Rail-Bending Machine for heavy rails with deep flanges. (3) Patent Colour Mixer for amalgamating colours with oil or other mediums.

525. LEADBETTER & CO., Plasket Works, Upton Park, London, E.—Self-setting Non-conducting Composition, for preventing the radiation or transmission of heat or cold.

526. HOPKINSON, J., & CO., Britannia Works, Huddersfield.—(1) Patent Improved Drying Cylinder. (2) Patent Anti-collapsible Copper Cylinders for bath boilers. (3) Patent Taps and Valves.

527. OWEN, THOMAS OWEN, Talysarn, Pen-y-Groes, R.S.O., near Carnarvon, N.W.—Owen's Feed Water Heater.

528. ROCKING FIRE BAR SYNDICATE, Limited (THE), 259 Gresham House, Old Broad Street, London, E.C.—(1) Patent Diagonal Rocking Fire Bars, with patent automatic rocking apparatus. (2) Patent Movable Fire Bridge.

529. MOFFATT, ALEXANDER, 26 College Street, Dowgate Hill, London, E.C.—The Eclipse Feed Water Heater and Fuel Economiser, for heating feed water for steam boilers up to 206° Fah., by utilising exhaust steam from an engine, and for intercepting impurities in the feed water, and preventing them entering the boiler.

530. WHITLEY PARTNERS, Railway Works, Hunslet Road, Leeds.—(1) Whitley's Patent Spun Liners for propeller shafts, hydraulic rams, air pumps; also steam piping and piston rings. (2) Whitley's Patent Spun Embossing and Printing Rollers. (3) Bronze Model of Whitley's Patent Rotating Steam Boiler. (4) Whitley's Improved Patent Allen Governor. (5) Whitley's Patent Oil Pump for lubricating the surface of propellers, and which is also adapted for life boat purposes. (6) Whitley's Patent Composite Rollers in steel and iron. (7) Whitley's Patent Composite Plate for shipbuilding and other purposes, consisting of eight (8) separate parts. (8) Whitley's Patent Double Conic Joint for steam water, and gas purposes. (9) Spun and drawn samples of Mild Steel.

531. MARCHANT, R. M., C.E., 68 Fenchurch Street, London, E.C.—Process for the retention and circulation of steam in engines.

532. TYLER, HAYWARD, & CO., 84 & 85 Whitecross Street, London, E.C.—Hayward Tyler & Co.'s Rider's Patent Caloric or Hot-air Engine for pumping; used for water supply of railways, houses, villages, &c., and for irrigating. This motor gives security against any danger of explosion, and

rest convenience in working, owing to the simplicity of its parts, the engine being without valves of any sort; the economy of fuel is also great for such a small motor.

53. THOMSON, ARCHIBALD, 66 Rosemoor Road, Stamford Hill, London, E.—Coupling for broken shafts, for marine and land engines.

54. KIRKALDY, JOHN, 40 West India Dock Road, London, E.—(1) Fresh Water Distillers. (2) Surface Condensers. (3) Feed Heaters, for marine and land boilers. (4) Cooling Machines.

55. MADAN, C. SPENCER, 21 Mansfield Chambers, St. Ann's Square, Manchester.—(1) Borland's Patent Injectors. (2) Madan's Patent Check Valve. (3) Fletcher's Patent Automatic Injector. (4) Madan's special Boiler Fittings for use with above.

56. BRIERLEY, WILLIAM, Borough Brass Works, Rochdale.—(1) Patent Dead Weight Safety, and Mercurial Safety Valve, for steam boilers. (2) Relief Valve for steam engine cylinders. (3) Sight Feed Lubricator.

57. TURNBULL, ALEXANDER, & CO., St. Mungo Works, Brook Street, Glasgow.—Improvements in safety valves, safety protector, steam boilers, low water indicator, and automatic boiler feeder.

58. FAULL, E. M. B., 30 Manley Place, Kennington Park, London, S.—Faull's Patent Gun-metal and Composite Packing, specially adapted for excessive pressures for steam, water, and other fluids, greatly used in marine and stationary engines.

59. JOYCE & UNSWORTH, 2 Finsbury Avenue, Curtain Road, London, E.—Piston Plug Cock.

60. WILSON, ALEXANDER, & Co., Vauxhall Iron Works, Wandsworth, London, S.W.—Payton and Wilson's Patent Circular Balanced and Double-ported Slide Valve and Valve Gear.

61. BUCKLEY, W., & CO., Patent Iron Works, Mill Sands, Sheffield.—Improved Patent Compensating Metallic Piston Packing. The samples exhibit two examples of packings, one with two outer rings, the other with one outer and one inner ring, fitted with compound springs. Applicable to steam cylinders, air cylinders, piston valves, pump buckets.

62. HOLBOROW & CO., Dudley Iron Works, Dudbridge, Stroud.—Automatic Expansion Valve and Gear for steam engines.

543. JOY, DAVID, 8 Victoria Cham- bers, Westminster, London, S.W.—Improvements in Steam Engines, being a new and improved valve gear for reversing and giving expansion. Also a method of coupling the parts of crank axles.

544. METALLIC VALVE CO. (THE), 28 Brunswick Street, Liverpool.—Valve Apparatus for air-circulating and other pumps.

545. PROCTOR, JAMES, Hammerton Street Iron Works, Burnley.—Patent Mechanical Stoker and Moveable Fire Bars.

546. BEVERIDGE, JAMES, Soho Foundry, Barrow-in-Furness.—Beveridge's Patent Valve Gearing.

547. ASBESTOS CO., Limited (THE UNITED), 161 Queen Victoria Street, London, E.C.—(1) Improvements in Asbestos Packing for the stuffing-boxes of valves, spindles, piston rods, and for steam joints, manhole doors, &c., of steam engines and boilers. (2) Improvements in making the joints of moulds. (3) New Combinations of Asbestos and India-rubber for steam jointing purposes. (4) Specimens of raw Asbestos.

548. PATENT EXHAUST STEAM INJECTOR CO., Limited (THE), 4 St. Ann's Square, Manchester.—[Davies, Hamer, and Metcalf's Patents.] (1) Exhaust Injectors, worked by exhaust steam only, also special ones for locomotives. Nozzles in actual use over three years. Photographs showing construction and arrangement. (2) Re-starting Injectors, instantaneous in starting and automatic in re-starting.

549. BRUNSWICK FOUNDRY CO. (JOSEPH PRICE & CO.), 39 Sefton Street, Liverpool.—(1) The Brunswick [Price's Patents] Condenser, Heater, or Refrigerator, for distilling fresh water from salt. (2) Heating Feed Water. (3) Cooling Milk, Worts, &c.

550. OSWALD, W. R., 75 Gracechurch Street, London, E.C.—(1) New Elastic Metallic Packing. (2) Corrugated Metallic Jointing. (3) New Metallic Filter. (4) Patent Metallic Valve.

551. OTWAY, H., Simplex Engine Works, 37 South Lambeth Road, London, S.W.—Three-Cylinder High Speed Steam Engine, 4-horse power.

553. PORTEOUS, A. N., 1 Viewforth Park, Edinburgh.—Rotary Steam Engine.

554. CORMACK, DANIEL ADAM, 27 Quality Street, Leith.—Compound Surface Condensing Steam Engine, suitable for launches, fishing vessels, &c.

555. TIPPING, HENRY, 5 Circus Street, Greenwich, London, S.E.—(1) Improvements in the method of and apparatus for working the valves of steam or hydraulic engines, for starting, stopping, or reversing the same. (2) Steam Engine Slide Valve Apparatus. (3) Prime Movers, and means of distributing their power. (4) Apparatus employed in generating steam for use in marine and other engines.

556. LOCKWOOD & CARLISLE, Eagle Foundry, Park, Sheffield.—Lockwood's Patent Double-action Metallic Piston Packing Rings and Springs.

557. ROYLE, JOHN JAMES, 27-29 King Street West, Manchester.—(1) Patent Box and Expansion Steam Trap. (2) Separator and Steam Trap combined. (3) Universal Unions and Bends. (4) Engine Lubricator, the Oleojector. (5) Reducing Valve. (6) Syphonia Steam Trap. (7) Hydraulic Test Pump.

558. MORTON & THOMSON, 96 Buchanan Street, Glasgow.—Ejector Condenser applied to steam engine and pump.

559. STEVENSON & DAVIES, 11 Queen Victoria Street, London, E.C.—Patent Cestus Vertical Boiler [Joicey's Patent]. Specially adapted for driving ships' winches, steam cranes, vertical land boilers, &c., &c.

560. BROWN, JOHN, 634 King's Road, Fulham, London, S.W.—The Continuous Tube Locomotive Steam Boiler. Suitable as a marine or stationary boiler, also as a hot-water boiler.

561. CLARK, WILLIAM, Engineer, 19 Lee Street, Plumstead, Kent; and at Royal Laboratory Department, Royal Arsenal, Woolwich.—Models of Improvements in Steam Boiler Furnaces and Flue Tubes, whereby the heated current gives out a double action and causes a more rapid evaporation of the water contained in the boiler, with less consumption of fuel.

562. MOY, THOMAS, 8 Quality Court, Chancery Lane, London, W.C.—Non-priming Steam Boilers. The water is carried in annular frustums of cones, thereby affording large water surfaces for the easy separation of the steam from the water.

563. PINCHBECK, J., 9 Victoria Chambers, Victoria Street, Westminster, London, S.W.—Improved Rotary Steam Engine.

564. BUMSTED, FRANCIS D., Cannock Chase Engine Works, Hednesford, Staffordshire.—High Speed Steam Engine [Chandler's Patent], for driving dynamo

machines direct or by means of rope gear. The special features in this engine are the lubrication and expansion of steam.

565. COLEY-BROMFIELD, J., 5 Westminster Chambers, London, S.W.—Steam Generators and Fuel Economisers.

566. BATCHELOR, H. & T. C., West Kensington, London, S.W.—A Patent Motion Drawing of the engines of the steamship "America," 9000 H.-P., constructed by Messrs. James & George Thomson, Clyde bank.

567. ARUNDEL & CO., Bromley Street Works, Ashley Lane, Manchester.—Moscrop's Patent Continuous Engine Speed Recorder.

568. HANCOCK INSPIRATOR CO. (THE), 108 Upper Thames Street, London, E.C.—The Hancock Inspirator. A new combination, embracing the duties of a pump and an injector, with means to use either independently. Lifts cold water from a depth of 25 ft., and feeds direct to any steam boiler at temperatures varying from 150° Fahr. to 212° Fahr., according to steam pressure. Works hot water upon low lifts.

569. BODDY, J. H., 42 Hilary Street, Leeds.—Pulleys.

570. BOWLING IRON CO., Limited (THE), Bradford.—Expansion Hoops for strengthening boiler flues.

571. TERRELL, W., & SONS, Wels Back, Bristol.—Engine Packings for locomotives, marine and stationary engines, and hydraulic engines.

572. SMITH, J. H., 436 Euston Road, London, N.W.—Automatic Marine Governor, controlled by the action of the engine and never moves unless necessary to cut off steam, and in proportion [only] to the propeller leaves or enters the water.

573. GOWAN, E. D., & CO., Steam Mills, Richmond Street, Bath Street, London, E.C.—High Pressure Valves.

574. ETHERINGTON, JOHN, 36 King William Street, London Bridge, E.C.—(1) Improvements in Steam and Water Valves, Sluices, &c., for high and low pressure mains and connections. (2) Improved Automatic Sight-feed Lubricator.

575. HAMAND, ARTHUR S., Palace Chambers, Bridge Street, Westminster, London, S.W.—Improvements in Locomotives and other Engines.

576. HARKER, FRANCIS TODD, Bevan Terrace, Stockton-on-Tees.—(1) Compound Surface Condensing Yacht or Launch Engine for high speeds and pressures. (2) Improved Inverted Launch Engine, with cylinder, standard and bed-plate cast entire.

577. MORTON, WILLIAM C., Longfield Villa, Coleshill, Birmingham.—(1) Improved Steam Traction Engine, unique steering qualities; of great utility for agricultural work. (2) Ploughs, with novel features for work with above engine or otherwise. (3) Wheels for Traction Engines, carrying weight over soft ground without deteriorating soil.

578. THOM, JOHN, 8 Storey Square, Barrow-in-Furness.—Thom's Patent Economical Slide Valve; transfers the steam from one side of the piston to the other just before exhaust opens to the condenser, thereby filling the ports of steam, which acts as cushioning for the piston, and then used over again on the return stroke. A material saving is thus effected of steam which would otherwise pass into the condenser.

579. HAWTHORNS & CO., Great Junction Street, Leith, N.B.—Surface Condensing Marine Engine, with Chapman's Patent Combined Air and Feed Pump and Air Extractor.

580. YOUNG, DOWSON & CO., Emmett Street, Poplar, London, E.—Securing flanges to copper and brass tubes.

581. DANSEY & ROBINSON, Engineers, 14 Gracechurch Street, London, E.C.—Improvements in Marine Compound Surface Condensing Engines, introducing a greater economy of steam, reduction of the number of working parts, and generally simplifying the construction; especially suitable for tugs or launches working in salt water.

582. BECK & CO., Limited, 180 Great Suffolk Street, Southwark, London, S.E.—Automatic Visible Drop Lubricators [Schönheyder's Patent], for lubricating the cylinders, pistons, slides, and internal working parts of stationary, marine, or locomotive engines.

583. BAPT, F., 7 Park Street, Leeds.—(1) The Omnivoltent Rotary Engine. (2) Fox's Patent Anticollide, for automatically operating steamship whistles during a fog.

584. HOCKEY & CO., Chard, Somerset.—Hockey's Patent Rotary Engine, actuated by water; also applicable as pumps.

585. GOODFELLOW & MATTHEWS, Hyde, near Manchester.—Matthews' Patent High Speed Compound Tandem Triplex Engine, for driving dynamos, pumps, fans, or other high speed machines direct.

586. FAIRFAX, J. S., 3 St. Paul's Road, Camden Square, London, N.W.—(1) Improvements in Motive Power Engines. (2) Rotary Engine adaptable for gas, steam, hot-air, &c. (3) Reversible and Variable Cut-off Valve Gear, worked by one eccentric.

587. BATES, TIMOTHY, & CO., Bank Foundry, Sowerby Bridge, Yorkshire; London Offices: 37 Walbrook, E.C.—(1) Newly Designed Steam Launch Engine. (2) Cooper and Wigzell's Deep-sea Sounding Instruments. (3) Patent Incandescent Lamps. (4) Wigzell & Pollit's Patent Air Pump with Condenser for horizontal steam engines. (5) Wigzell & Pollit's Patent Steel Coils for pistons, &c. (6) Sugden's Patent Plunger Displacement Lubricator.

588. CUMMINS, W. R., Sheepcotes, Chigwell Row, Essex.—Improvements in Valve Gear.

589. BERNAYS, JOSEPH, 96 Newgate Street, London, E.C.—Patent Twin Cylinder Marine Engines, with improved valve motion. Made either compound or for high pressure, and equally economical for the largest as for the smallest vessels.

590. HARDING, C. W., Kings Lynn, Norfolk.—Telegraph Ship and Vessel, for generating energy by means of the waves of the sea.

591. ELLINGTON & WOODALL, 9 Bridge Street, Westminster, London, S.W.—The Distribution of Hydraulic Power in London and elsewhere.

592. VERNON, ISALAH, Great Bridge, Tipton, Staffordshire.—Improvements in Steam Engines for utilisation of waste steam from all high pressure engines, more particularly locomotive engines, so that from 50 to 100 per cent. of the original power can be reproduced without boiler or extra fuel.

593. BLACKBURNE, W. E., 24 Canning Street, Liverpool.—Self-Acting Steam Tube Cleaners.

594. RICHARDSON, JOHN, 64 Torriano Avenue, Camden Road, London, N.W.—Steam Engine Indicator, for taking continuous diagrams.

595. LISHMAN, THOMAS, 19 Blenheim Street, Newcastle-on-Tyne.—Apparatus for purifying and heating water, &c.

596. BRITISH MEKARSKI IMPROVED AIR-ENGINE CO., Limited (THE), 110 Cannon Street, London, E.C.—The Mekarski Improved Compound Air-Engines, for railway and tramway traction:—(1) Tramcar Engines—Joseph Clayton, Scho

Foundry, Preston, Lancashire. (2) Tramcar Body—The Lancaster Wagon Co., Limited, Railway Carriage and Wagon Builders, Lancaster [W. C. Shackelford, Manager]; London Office, 1 Victoria Street, Westminster, S.W. (3) Air Compressing Machinery—The General Engine and Boiler Co., Hatcham Iron Works, Pomeroy Street, New Cross Road, London, S.E. (4) Permanent Way—The Denham-Olipherts-Molesworth system; Agents for Patents, Messrs. Thomson & Browning, 3 Victoria Street, Westminster, S.W. (5) Electric Signalling Apparatus—Mr. J. A. Timmis, 2 Great George Street, Westminster, S.W. (6) Signals painted with the Patent Foo-Chow Enamels, which dry in three minutes, and are impervious to rain and atmospheric influences—Donald Macpherson & Co., Knott Mill, Manchester, 106 Cannon Street, London, E.C. (See *Outside, South Promenade.*)

597. **DICK, KERR, & CO.**, 101 Leadenhall Street, London, E.C.; Britannia Engineering Works, Kilmarnock. —Kerr's Patent Portable Railways. (See *Outside, South Promenade.*)

598. **KERR, STUART, & CO.**, 20 Bucklersbury, London, E.C.—Appliances used in the construction of portable railways and light narrow gauge railways, rolling stock, locomotives, steam launches, tugs, and barges. (See *Outside, South Promenade.*)

599. **SMITH, M. HOLROYD, & CO.**, Halifax. —Electric Tramways. (See *Outside, South Promenade.*)

ADAMS, J. H., 34 Fullerton Road, Wandsworth, London, S.W. (See *Group XIII.*)

ALLIX & TRUDYETT, 72 Walker Street, Burdett Road, London, E. (See *Group X.*)

ANDERSON & GALLWEY, Cremona Works, Lot's Road, Chelsea, London, S.W. (See *Group XI.*)

APPLEBY BROS., 89 Cannon Street, London, E.C. (See *Group XI.*)

AYRTON & PERRY, 73 Great Eastern Street, London, E.C. (See *Group XIII.*)

BATEMAN, A. H., East Greenwich. (See *Group X.*)

BERNARD, JULIAN, 137 Long Acre, London, W.C. (See *Group III.*)

BERNAYS, JOSEPH, 96 Newgate Street, London, E.C. (See *Group XI.*)

BEZER, HENRY, 12 Teddington Park Road, Teddington. (See *Group XI.*)

BROCKELBANK, HENRY, 4 Old Jewry, London, E.C. (See *Group V.*)

CALENDER'S BITUMEN TELEGRAPH AND WATERPROOF COMPANY, Limited (THE), 101 Leadenhall Street, London, E.C. (See *Group XIII.*)

CAMBRIDGE SCIENTIFIC INSTRUMENT CO. (THE), St. Tibb's Row, Cambridge. (See *Group XXVIII.*)

CAMERON, LIEUT.-COL. D. R., R.A., Sheerness. (See *Group XII.*)

CARPENTER, JAMES, 20 Dorset Street, New Town, Southampton. (See *Group VII.*)

COXETER & NEHMER, 23 & 24 Grafton Street East, Tottenham Court Road, London, W. (See *Group XIII.*)

DAVEY, PAXMAN & CO., Engineers, Colchester. (See *Complimentary List*, page xlv.)

DAVIS & CLOW, St. Helen's Works, Abingdon, Berks. (See *Group VII.*)

ENGELBERT & CO., 70 & 71 Bishopsgate Street, London, E.C. (See *Group XIV.*)

GREENWOOD & BATTEY, Albion Works, Leeds. (See *Group X.*)

GULCHER ELECTRIC LIGHT AND POWER COMPANY, Limited (THE), 4 Coleman Street, London, E.C. (See *Group XIII.*)

HATHORN, DAVEY, & CO., Leeds. (See *Group XI.*)

HAWTHORN & CO., 22 Charing Cross, London, S.W. (See *Group II.*)

HILL, F. B., 69 Camplin Street, New Cross Gate, London, S.E. (See *Group XI.*)

HOLDEN & BROOKE, St. Simon's Works, Salford. (See *Group X.*)

HORNSBY, R., & SONS, Limited, Spittlegate Ironworks, Grantham. (See *Group I.*)

HOW, JAMES, & CO., 73 Farringdon Street, London, E.C. (See *Group XXVIII.*)

HYDRAULIC ENGINEERING CO., Limited (THE), Palace Chambers, Westminster, S.W. (*See Group XI.*)

KINETIC ENGINEERING COMPANY (THE), 36, 37 Brooke Street, Holborn, London, E.C. (*See Group XIII.*)

KINGSFORD, C., Lee Chemical Works, Hackney Wick, London, E. (*See Group XVI.*)

MACKENZIE, H. S., Penwenack, Falmouth. (*See Group VII.*)

MARKHAM & CO., 345 Edgware Road, London, W. (*See Group VI.*)

MARSDEN, ROBERT, Tinsley Park Works, Attercliffe, Sheffield. (*See Group III.*)

MATTHEWS, DANIEL, 67 Cornwall Road, Brixton Rise, London, S.W. (*See Group VI.*)

MAW, CHARLES, 12 Aldersgate Street, London, E.C. (*See Group VII.*)

MERRYWEATHER & SONS, Greenwich Road, S.E.; and 63 Long Acre, London, W.C. (*See Group XI., Queen's Gate Anneze.*)

NORDENFELT, T., 53 Parliament Street, London, S.W. (*See Group XXV.*)

PARKINSON, W., & CO., Cottage Lane Works, City Road, London, E.C. (*See Group XV.*)

PHOSPHOR BRONZE CO. (Limited), 37 Sumner Street, Southwark, London, S.E. (*See Group II.*)

RANSOMES, SIMS, & JEFFERIES, Limited, Orwell Works, Ipswich. (*See Group I.*)

REDDALL, WILLIAM, 10 South Street, Finsbury, London, E.C. (*See Group XIII.*)

SENNETT, A. R., & CO., 62 Hatton Garden, London, E.C. (*See Group XIII.*)

SHARP & CO., 11 Holborn Circus, London, E.C. (*See Group IV.*)

SMITH, A., & STEVENS, Janus Works, Queen's Road, Battersea, London, S.W. (*See Group XI.*)

SPENCER, JOHN, & CO., Atlas Works, Keighley, Yorkshire. (*See Group X.*)

TANGYE BROS., Cornwall House, 35 Queen Victoria Street, London, E.C. (*See Group XI.*)

TRAILL, W. A., Giant's Causeway Electric Tramway, Portrush, Co. Antrim. (*See Group XIII.*)

TYLER, HAYWARD, & CO., 84 & 85 Whitecross Street, London, E.C. (*See Group II.*)

WARD, CHARLES JAMES B., 5 Mitre Road, Ridley Road, Rochester. (*See Group VI.*)

WARNER, JOHN, & SONS, Crescent Foundry, Cripplegate, London, E.C. (*See Group XI.*)

WAYGOOD, R., & CO., Falmouth Road, Great Dover Street, London, S.E. (*See Group XI.*)

WEBB, FRANCIS WILLIAM, Locomotive Department, London & North-Western Railway, Crewe. (*See Group V.*)

WELMAN, JAMES, West Street, Poole, Dorsetshire. (*See Group III.*)

WESTINGHOUSE BRAKE CO., Limited (THE), Canal Road, King's Cross, London, N. (*See Group XI.*)

WILLIAMS, T. H., A.M.I.C.E., 23 Stamford Street, Blackfriars, S.E. (*See Group XI.*)

WILSON, J., VEITCH, & CO., 260 Dobbies Loan, Glasgow. (*See Group XIV.*)

WORTHINGTON PUMPING ENGINE CO. (THE), 114 Queen Victoria Street, London, E.C. (*See Group XI.*)

BRUCE & BATHO'S SYSTEM OF DREDGING & EXCAVATING, 9, VICTORIA CHAMBERS, WESTMINSTER.

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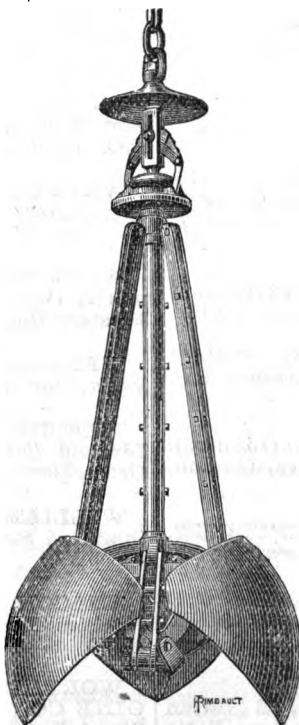
HYDRAULIC DREDGERS,

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To raise from 10 Cwt. to
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SPECIAL 4-BLADED

EXCAVATORS

For working in
Hard Material.

RAILWAYS.

BY CAPTAIN DOUGLAS GALTON, C.B., D.C.L., F.R.S., F.G.S., F.L.S., &c.

ONE of the most striking features in the progress which has taken place in the material comfort of all classes of the population during the last fifty years, is the increased facility for moving from place to place. The richer classes could always travel. They could pay for comfortable carriages, even though the bad state of the roads required the use of many horses; and thus they could always move from place to place with more or less of discomfort. This was not the case with the poorer classes; they had to walk, or at best could ride in the stage waggon which passed at unfrequent intervals and travelled at a rate little exceeding two miles per hour. Thus in former times the poorer classes were almost debarred from moving to any great distance from their homes. The present facilities of transit which the poorer classes enjoy afford a marvellous contrast to that state of things. The alteration is due partly to railways and improved roads; and partly to the development of mechanical skill and the great perfection to which workmanship has been carried. The accuracy which has been introduced into the performances of the various machines (greatly owing to the introduction of uniform gauges, of which Sir Joseph Whitworth was a great promoter) has enabled the manufacturer to turn out uniformly first-class work without being so entirely dependent as formerly upon the skill of the individual workman. The speed and smoothness to which railway travelling has attained would have been impossible without the machinery which makes an accurate fit in every detail; nor would the perfection with which road carriages are now built be possible without excellent machinery. In these latter the manufacture of wheels has undergone a remarkable change; and indeed the beautiful wheels and other appliances of the bicycle and tricycle could not have been imagined without perfect machinery. The improvements in the roads have been very remarkable. Before the introduction of railways the turnpike road was a first-class road, but the other roads were often badly formed and badly maintained; and it is certain that, in the absence of roads far superior to those which prevailed generally some fifty or sixty years ago, the bicycle and tricycle could not have attained to their present development. The application of steam to traction on any scale was impossible on an ordinary road, because the attempt to draw a number of vehicles by one engine results in the adhesion of the engine wheels tearing up the road. It is only by means of the hard surface which a railroad affords that the full effect of steam as a tractive force can be obtained by means of a locomotive engine. It is, moreover, to the railway that the public is largely indebted for the great improvements which have taken place in ordinary roads. The railway has introduced the habit of travel into the population; and this habit of travel has almost insensibly forced upon the community the improvement of the roads.

When railways were first introduced into this country the vehicles which were adopted were copied from the then ordinary road vehicles of the period. The first-class carriage was formed of a coupé in front, resembling the old postchaise, with its yellow panels; behind were bodies of the stage coach with its cramped accommodation. The second class were at first made with open sides, but subsequently altered to nearly resemble the first class, but with less window space and without cushions or lining. The third class were either open or dark boxes, often without seats.

It seemed as if railway managers considered the third class as only to be admitted on sufferance, and the Legislature had to interfere to obtain decent accommodation for this class which has now become, under more enlightened views, the most paying class of the community. Everything was done by the railway manager to make the lower classes uncomfortable, and thus to drive people to take higher class tickets. They did not recognise the importance of inducing or rather of educating the people to travel. It is to this aristocratic tendency which prevailed till within the last twenty years that the progress made up to that time in improving the vehicles on railways was so slow. Contrast this with America. In that new country the railroad was the easiest made road, and it became practically the only road for opening out her vast territory. Every one of necessity had to use it: the democratic feelings of the community, and the absence of a rich aristocracy, led the managers to adopt one class of carriage for all classes. The form of vehicle adopted was governed by another consideration. Before the introduction of railroads in

America the main lines of travel had followed the course of the rivers by means of steamboats. The idea of the American railroad car was borrowed from the saloon of a steamboat. The features which mark this adaptation are the self-contained arrangements in a carriage which make it unnecessary for through passengers to get out at roadside stations; the facility of moving about in the carriage or of standing in the open air on the platform; the facility of passing from one part of the train to the other. The Americans, in placing the steamboat saloon on wheels, were compelled by its length to adopt the bogie truck, an arrangement till recently peculiar to that country. The long distances passed over led them to convert the train into travelling hotels, and this example is at last being gradually followed in Europe.

The improvements which have taken place in railway carriages during the last twenty-five years may be said to date principally from the development of the third-class traffic. This development is largely due to the influence of Sir James Allport, who, as manager of the Midland Railway, introduced third-class carriages into all trains, an example speedily followed by all the other railway companies; the improved third-class accommodation necessitated alterations in the carriages allotted to other classes. These various improvements in railway plant naturally fall under the heads of economy, safety, and convenience. Increased economy in railway working in late years has been largely assisted by the improved road-bed, as well as by the improvements in machinery, which have diminished the train resistances. In respect of the road-beds the improvements in England are mainly due to the greater care bestowed on drainage and ballasting; the cross sleeper road with chairs appears hitherto to have retained the favour of engineers, although it may be predicted that sleepers of iron or steel, with adequate elasticity or cushions for the rail-bed, will eventually supersede them; in America, the plentiful supply of timber seems to have induced American engineers to adhere to the practice of spiking or bolting the rail to the sleeper without the intervention of a chair. The fished joint has become universal, but improvements are still being made in proportioning the strength of the fish-plate to the duty it has to perform, and in the method of its application. Iron rails are being largely superseded by steel rails. These improvements all tend to diminish the train resistances. The valuable series of experiments made by the Institution of Mechanical Engineers on lubricants, as well as a somewhat similar series in America, has an important bearing on the question of the train resistance due to the journal friction. These experiments illustrate in an interesting manner how the vehicle floats, as it were, on the lubricant, and they serve as a guide to the class of lubricant which it may be desirable to apply under differing conditions of speed; as well as to indicate the direction which might be advantageously followed in altering the form of the axle-boxes. It is remarkable that, although the question of train resistances has received some elucidation in the United States, we have in this country no connected published data on the question, since the experiments made at the time of the battle of the gauges, from 1844 to 1846, by Mr. Wyndham Harding and Sir Daniel Gooch. Since those experiments the road-beds have improved, the machinery has been improved in respect of form, material, and perfection of workmanship; the distances between carriages, which under certain conditions form an important element of train resistance, have been modified. Experiments have no doubt been made by individual locomotive engineers, and it would be of great value to collate these and to supplement them by a well-considered series of additional experiments.

So far as safety is concerned, the small number of accidents in the course of traffic is a source of constant wonder. Accidents to engine-drivers afford a fair measure of the comparative safety which has been attained. This is illustrated in an interesting manner in the reports just published of the Enginenen and Firemen's Mutual Assurance Society on the Great Western Railway; the results shown are as follows:—

	Average number of cases per 1000 members per annum.	
	Death.	Disablement.
1865-1869	4.0	3.0
1880-1884	1.3	1.1

and indeed it may be accepted as a near approximation to the truth that the number of these accidents is now not above one-third of what took place in 1862. The two great causes of accident which largely prevailed in the early days of railways, viz., the fracture of tyres and axles and collisions, may be said to have almost disappeared. The improved methods of fixing the tyres to the wheels, the increased strength in the tyres and their flanges, that is to say, the better proportions observed between the strength of the material and the work it has to perform; the improvements in the construction of wheels and axle-boxes, as well as the better understanding of the laws governing the nature of the material and its treatment and application, have all contributed to this result. But it must not be forgotten that the improved condition of the roadway on railways generally has had an important influence on the diminution of fractures of tyres and axles.

In respect to collisions, there are three improvements which have mainly contributed to diminish their frequency, and the general introduction of which the last twenty-five years have witnessed. Two of these relate to the road or the management, viz., the block system and the interlocking of switches and signals; and it is somewhat remarkable that electrical arrangements for effecting these purposes have not yet attained a wider practical application. The third appertains to the vehicles, viz., the continuous brake. It is remarkable how slow the railway companies were to introduce these improvements until compelled to do so, either by the force of opinion or by legislative enactment; and it is far from improbable that had the continuous brake been earlier introduced, the importance of the block system would not have been so fully recognised.

In the earlier days of railways it was thought sufficient to allow one brake to every six or eight carriages in a train; and with slow speeds and a limited traffic more brake power in a train was not so imperatively necessary as it now is. But under these conditions trains travelling at high speeds require a mile, and trains at lower speeds require often nearly half a mile in which to stop. Consequently, whilst in clear weather this small amount of brake power may not have always been a source of danger, when foggy weather prevailed, so that the state of the line far ahead could not be ascertained, collisions became frequent. Mr. Fay and Mr. Newall appear to have first suggested continuous brakes in this country, and their brakes were long in use on the Lancashire and Yorkshire Railway. But they could not be applied to more than a limited number of carriages. Various inventions followed, the main object of which was to convey force from the engine and the guard's van to act upon the wheel surface of each carriage. Steam and water, a vacuum, and air pressure have all been tried. At the present time the vacuum brake and the air-pressure brake (i.e. the Westinghouse) have been the most universally adopted. The points in continuous brakes which determine their value are, 1st, the power of so regulating the pressure as to prevent skidding of the wheels, because the skidded wheel has a much less retarding effect on the train than the braked rolling wheel; 2nd, the simultaneous application of the brakes to every wheel of the train. The importance of this is obvious with trains travelling at high speeds, and will be at once apparent from a consideration of experiments made on a train of twenty-one carriages with the air-pressure brake and the vacuum brake. With the pressure brake, on the application of the brakes, the brake-blocks began to move on the vehicle next the engine in a quarter of a second and in the last vehicle of the train in three seconds, and the brake was full on in one-and-a-half seconds on the vehicle nearest the engine, and in five-and-a-half seconds on the last vehicle of the train. With the vacuum brake, the brake-blocks began to move in half-a-second on the vehicle next the engine, and in five-and-a-half seconds on the vehicle at the rear of the train; whilst the pressure was not full on for seven seconds on the vehicle next to the engine, nor for more than half a minute on the vehicle at the rear of the train. These results are merely mentioned to illustrate the general aspect of this question, because important modifications have been introduced into both classes of brakes since these experiments were made. It is obvious that if a train is travelling at high speed, and if the brake-blocks are applied at the front of the train for some seconds before they act on the rear vehicles, the tendency would be for the rear vehicles to override the front vehicles. There is another important point which a continuous brake should possess, viz., it should be automatic in its action if a train breaks asunder—that is, the separation of a part of the train should cause the brakes at once to be applied. It is to be hoped that before long the automatic continuous brake will be equally applied to goods and passenger trains.

There is one class of accident on railways which has not yet led to material improvement in the machinery of railway carriages, viz., accidents from coupling and uncoupling the vehicles. The buffers, couplings, and carriage connections generally have not undergone much change in the last twenty-five years; and the old methods of attachment still leave much to be desired. The main features of improvements in the comfort of railway carriages which have been introduced in the last twenty-five years are partly due to the recognition by railway managers that the third class afford productive traffic, and deserve therefore fair treatment and encouragement; consequently the third-class carriages have been materially improved. The increased distances over which trains now run without stopping have led to the introduction of lavatory carriages in the first class, an improvement apparently derived from American example. This is a feature of carriage construction which is rather applicable to trains travelling long distances than to a particular class, and which is of equal importance for all classes carried in the long distance trains. The warming of carriages has been improved on well-conducted railways, so far that the third-class passenger is no longer debarred from a foot-warmer, but the arrangements for warming still involve much labour and trouble, and are not very effective. The principle in this country is simply to store the heat in a metal vessel by means of hot water. The fire, with a boiler and hot-water pipes, used in the Pullman car, have not received extension in this country; and no doubt, under the best arrangements, a fire presents elements of danger in case of accidents. An improved method of utilising stored-up heat has recently been applied to foot-warmers by the London and North-Western Railway Company, which deserves notice, as it saves labour, although it does not seem to have been adopted on other railways in this country. This consists of using in the foot-warmer acetate of soda instead of water. Acetate of soda is a neutral salt in crystals, which melts somewhere about the boiling point of water. The foot-warmer, after being completely filled with the crystals of this salt, is sealed hermetically. The foot-warmer is then put in an oven, or in a bath of boiling water, until the crystals are melted, and the acetate of soda assumes a liquid form. The foot-warmer will then cool down gradually, in which operation the liquid crystallises. During this crystallisation it throws out the latent heat absorbed to convert the salt from a solid to a liquid form. It is said that these foot-warmers remain hot for eighteen hours, and that even then the crystallisation is incomplete, and that on tapping or shaking the foot-warmers the crystallisation of those parts of the substance which had remained uncrystallised commences, and the foot-warmers become hot a second time. The lighting of railway carriages on most lines also leaves much to be desired, but it is satisfactory to find that improved methods of lighting railway carriages are now receiving attention. The gas-lighted carriages were a great advance upon oil; but the electric light bids fair soon to supersede both. There are two methods of applying the electricity which are under trial, and a mention of which will sufficiently illustrate the practice for present purposes. One is to place a dynamo in the van worked by the rotation of the axle, the electricity from which is collected in a storage battery, and is available for use whether the train be moving or stationary and whether the engine be attached or not to the train. The other is the generation of electricity by a small auxiliary engine attached to the boiler of the train engine, which supplies light to the train so long as the engine is attached to it. The subject of the lighting of trains by electricity is now in its infancy, but it cannot be doubted that before long, in consequence of its great convenience, it will supersede every other form of lighting for train service on railways.

The gradual improvements which have taken place in the last twenty-five years in the comfort of railway carriages are traceable to the competition for thorough traffic of the main lines of railway. Those lines where competition is absent are often treated to scant accommodation and to antiquated carriages; but by degrees, as the standard of accommodation is raised in the country generally, they also attain to a participation in the improvements, and the progress made in the last twenty-five years certainly justifies the view that the system upon which the railways of this country are constructed and managed by private enterprise has hitherto been of enormous and progressive benefit to the public, and so long as this competitive spirit prevails the improvements will continue.

GROUP V.—RAILWAY PLANT.**SOUTH GALLERY, MIDDLE COURT.**

[For Construction of Railways and Tramways, see Group III.; for Locomotives, see Group IV.; for Common Road Locomotives, see Group VI.; for Signals, see also Group XIII.]

603. HEBERLEIN SELF-ACTING RAILWAY BRAKE CO., Limited, 18 St. Dunstan's Hill, London, E.C.—Automatic Friction Brake for railways and steam tramways, and available both as a hand-brake and continuously. Groups of these brakes can also be worked in goods trains by a single brakeman or by the engine-driver, whilst they provide a cheap and simple form of engine brake for emergencies.

604. McKENZIE & HOLLAND. Railway Signal Engineers, Worcester.—(1) Full Size Apparatus for working and interlocking railway points and signals at a station with a level crossing, with gearing for working crossing gates interlocked with points and signals. (2) Model of a Station with level crossing, illustrating the working and interlocking of railway points, signals, gates, and wickets. (3) Model of a Railway Junction, showing the working and interlocking of points and signals with Fisher's patent improved facing point lock. Also other railway safety appliances.

605. WEBB, FRANCIS WILLIAM, Locomotive Department, London & North Western Railway, Crewe.—(1) Improvements in or applicable to locomotive and traction engines. (2) Improvements in radial axleboxes for locomotive and other rail and tramway vehicles. (3) Permanent Way of Railways. (4) Interlocking Signalling Apparatus. (5) Actuating Railway Points and Signals.

606. MERRYWEATHER & SONS, Greenwich Road, S.E.; and 63 Long Acre, London, W.C.—Locomotive for street tramways. The engine is fitted with improved air condenser, speed governor, steam brake, duplicate levers. It is specially adapted for steep gradients, and is free from noise either of blast or machinery. It is also smokeless, and the exhaust steam is effectively condensed.

607. WESTINGHOUSE BRAKE CO., Limited (THE), Canal Road, King's Cross, London, N.—(1) Automatic Air Brake and Passenger Communication for railway trains. (2) Direct-acting Pumps for air, vacuum or water.

608. SAXBY & FARMER, Canterbury Road, Kilburn, London, N.W.—Railway Signals and Safety Appliances.

609. VACUUM BRAKE CO., Limited (THE), 32 Queen Victoria Street, London, E.C.; Engineer, **ALFRED L. SACRÉ, C.E.**—The Vacuum Automatic Continuous Brake, with universal coupling.

610. FALCON ENGINE AND CAR CO., 41 Coleman Street, London, E.C.—(1) Steam Tramway Engine. (2) Working Drawing of condensing tramway engine [Scott Russell's Patent]. (3) Photographs of engines and cars.

611. BLACK, HAWTHORN, & CO., Gateshead-on-Tyne.—Steam Tramway Motors.

613. WILSON, J. EDWARDS, Rosedale Villa, Leytonstone, Essex.—(1) Improved System of constructing railway vehicles, with central buffing and drawing. (2) Apparatus for working switches, crossings, and signals, with automatic adjustment for heat and cold. (3) A Continuous Brake independent of the bearing springs in action.

614. KELLY, R. R., 3 Pall Mall East, London, S.W.—(1) Railway Brake and Signalling. (2) Pneumatic Brake. (3) Working Vacuum Brake Apparatus.

615. HARDING, A. B., 1 Albion Villas, Catford, London, S.E.—Improved Screw Brake.

616. HEARD, THOMAS, 3 Victoria Street, Sheffield.—Patent Telescopic Railway Wagon Chain Lifter and Coupler.

617. HUMBERSTONE, JAMES S., Byworth Villa, Glenhurst Road, Brentford, W.—Improvement in brakes, blocks, &c.

618. CLAY, RICHARD, Muswell Hill, London, N.—Signalling Apparatus to supersede semaphores and fog signals.

619. BARROW, THOMAS, The Oaks, Rock Lane, Rock Ferry, Birkenhead.—Detonating Signals for railways.

620. WELCH, E. J., COWLING & SMITH, W. PARKER, Palace Chambers, Bridge Street, Westminster, London.—The Welch-Parker Smith Automatic Brake for railway and other vehicles. The action of the brake is controlled either by hand, or by a vacuum, or by compressed air, according to the system with which the engine of the train happens to be fitted.

621. DUPLEX BRAKE CO. (THE), 11 Queen Victoria Street, London, E.C.—Vacuum Brake Apparatus for use on railway trains.

622. KAYE, J., & SON, 93 High Holborn, London, W.C.—(1) Lock for railway doors. (2) Patent Railway Coupling.

623. HODGSON, A. P., 4 Morton Place, London, S.W.—Self-acting Railway Station Indicator. It is placed in each carriage to notify to travellers the approach of the train to a station at which he is about to stop or change carriage. It is entirely automatic whether the train travels on the main line, branch or connection line. It consists of a map and a rod worked by contact surfaces between the rails.

624. RIDSDALE & CO., 54 Minories, London, E.C.—Railway Lamps.

625. MOORE, A., Sekforde Works, St. James' Walk, Clerkenwell, London, E.C.—(1) Railway Lamp Reflectors. (2) Railway Ventilators.

626. CHIDLEY, RICHARD, 39 Whittington Road, Wood Green, London, N.—Improved Registering Fog Signalling Apparatus, for use upon railways.

627. MILDRED, ALFRED S., 114 Grange Road West, Middlesbrough.—Coupling Apparatus. A simple but effective arrangement for coupling and uncoupling railway trucks from the side, avoiding the necessity for railway servants passing between the buffers or over the rails.

628. HALL, JOHN D., 3 Victoria Terrace, Newburn.—Spring Compensator for adjusting and preventing breakage, and taking off dead weight, &c., in the working of signal wires on railway signals or telegraph wires.

629. LAMMERS, C. L. H., 2 Roseworth Terrace, Gosforth, Newcastle-on-Tyne.—Improvement in tramcars, railway carriages, and other vehicles.

630. RHOADES, G. W., 5 & 7 Laburnum Street, Kingsland Road, London, E.—Automatic Couplings of railway trucks and carriages.

631. HUMBLE, STEPHEN, 5 Westminster Chambers, Victoria Street, London, S.W.—Safety Drawbar for Railway rolling stock.

632. McLAREN, R. L., 20 Bucklersbury, Queen Victoria Street, London, E.C.—Improved Device of varying the gauge of carrying wheels, especially railway wagons, thus avoiding the cost and risk of transhipping goods from one gauge to another.

633. BEAUMONT, H., 104 Grosvenor Road, Thames Bank, London, S.W.—Automatic Railway Coupling.

634. MORRIS, H., Queen's Chambers, Manchester.—(1) Railway Signalling for foggy weather. (2) Pouget's Speed Recorder. (3) Pignatelli's Ventilator for railway carriages, for the supply of air without dust. (4) Morris & Pouget's Lubricator.

635. JOHNSON'S COMPENSATOR CO., Limited, Queen's Chambers, John Dalton Street, Manchester.—(1) Liquid Compensator for signal wires. (2) Rack and Pinion Compensator for point rods. (3) Detector Springs for facing points. (4) Improvements in railway signalling during foggy weather. (5) Pouget's Speed Recorder for locomotive and other engines. (6) Morris & Pouget's Lubricator. (7) Pignatelli Ventilator for railway carriages, for the supply of air without dust.

636. RICHARDSON & GREEN-WOOD, Parliament Street, Harrogate.—Improvements in apparatus for coupling and uncoupling railway carriages, locomotives, and vehicles. (1) Apparatus for tightening or slackening the couplings of passenger trains. (2) Improved Duplex Safety Drawbars for railway rolling stock.

637. SYKES, W. R., 84 Kirkwood Road, Nunhead, London, S.E.—Combined Electric Interlocking and Blocking System for railways.

638. MAWLAM, WILLIAM, 17 Vane Street, Stockton-on-Tees.—Coupling and Uncoupling Railway Trucks.

639. HARRISSON, JOHN, 185 Wall Street, Hackney, London, E.—Automatic Apparatus for interlocking, and other railway signals. Every train in passing ensures the signal being placed at danger, until taken off by the signalman only, and who can actuate it to danger at any moment, in the usual way.

640. BANISTER, F. D., Engineer's Office, London, Brighton & South Coast Railway, London Bridge Terminus, London, E.C.—Safety Lock for points and signals.

641. COWDY, J., & CO., 40a Queen Street, Cannon Street, London, E.C.—(1) Patent One-handed Tricolour Signal Lamp. (2) Patent Lock Nut Lever Frame, showing new trigger and lever locking for railway signals. (3) Parabolic Engine Head Lamps.

642. JONES, W. R. S. (Agent, E. PRINCE), 262 Gresham House, Old Broad Street, London, E.C.—Patent Flexible Buffer and Screw Coupling.

643. THOMPSON, WILLIAM, 18 Phoenix Street, Newsham Fresholds, Blythe, Northumberland.—Lock Switch and Wire Compensator.

644. **BELLING, GEORGE F., 2** Manor Park Road, Manor Park, Essex. —Improved Automatic Coupling for railway trucks, wagons, and other vehicles.

645. **HENSON & CO.,** Brook Side Iron Works, Nun's Street, Derby. —(1) Railway Signal Wire Regulator. (2) Apparatus for placing fog signals on rail or replacing in apparatus if not required. [Worked from signal box.]

646. **SCOTT, U. H., 15** Kentish Town Road, London, N.W. —Improvements in Carriages. (1) Patent Elastic Naves and wheels. (2) Noiseless Window Rollers. (3) Patent India Rubber and Roller Break Blocks. (4) Also a means by which passengers can call the attention of the guard and driver to any compartment of any carriage in the train in case of necessity.

647. **BOSHER, F. H. & F. E., 70** Regent's Park Road, London, N.W. —The Compressible and Sliding Platform Safety Railway Carriage. Constructed so as to absorb and thus lessen the shock on the occurrence of collisions. This invention is equally adapted to every description of rolling stock.

648. **PIONEER PAINT CO., Limited** (THE), 5a Aldermanbury Postern, London, E.C. —Luminous Railway Carriage, being a model of the coach now running on the South Eastern Railway Co., the interior being entirely painted with Balmain's luminous paint.

649. **FIDLER, T. CLAXTON, 13a** Great George Street, Westminster, London, S.W. —(1) Improvements in the rolling stock of railways and tramways. (2) Improved Valve-Gear for railway or tramway locomotives or other steam engines.

650. **GOVER, H. CHARLES, Beech-**wood, Claremont Road, Highgate, London, N. —Patent Draught Shield Railway Carriage Window. Swings open on either side, as well as moving up and down; suitable also for road carriages.

651. **ROBINSON, J. B., Crown** House, Winchester Terrace, Park Lane, Waltham, Middlesex. —Improved Sliding Window for railway carriages, broughams, omnibuses, dinner lifts, enquiry machines, &c.

652. **PAYTON, WALTER, 38** Massey Road, Brook Green, Kensington, London, W. —Improvement in carriage door.

653. **LAYCOCK, WILLIAM S.,** Hammoor, Sheffield. —Patent Self-acting Sliding Window Blind Apparatus, for railway carriages, steamboats, tramcars, household purposes, &c.

654. **RICHARDSON, JOHN, 64** Torriano Avenue, Camden Road, London, N.W. —Improvements in the construction of tramways and tramway wheels, for rendering the roadway less objectionable to ordinary vehicles.

655. **GROOMBRIDGE, CHARLES,** Clifftcote, Oliver Road, Leyton, Essex. —Auto-pneumatic Apparatus for fastening doors of railway and other carriages while in motion, and unfastening the same on the cessation of motion. The object of this invention is to prevent passengers entering or alighting from carriages while such carriages are in motion.

656. **BRADLEY, WILLIAM, 18** Collegiate Crescent, Broomhall Park, Sheffield. —Improvements in locks and latches.

657. **WALTON, WILLIAM, & G. T. IRVING,** Murton House, Bishopwearmouth, Sunderland. —The Wing Coupling, an invention for coupling and uncoupling railway rolling stock direct from engine or brake van. Can be worked while train is either standing or in motion.

658. **SHARPLEY, C. P., 23** Villa Road, Brixton Road, Brixton, Surrey. —Anti-dangerous Life-preserving Couplings for railway carriages, self-acting or otherwise.

659. **ROE, JAMES THORNE,** Earlsfield Villas, Balham Park Road, London, S.W. —The Roe Coupling for automatically coupling and uncoupling railway wagons, &c.

660. **STONE, ROBERT, 83** Lawrence Hill, Bristol. —Improved Coupling for railway vehicles. Any number of vehicles can be attached or detached, standing or running, at any speed, or at any given point.

661. **DAVIS, ALFRED, Parliament** Mansions, Westminster, London, S.W. —The Janney Coupler and Buffer.

662. **SIMPSON, D. K., St. George's** Crescent, Liverpool. —Railway Station Automatic and Non-Automatic Indicator.

663. **BOLT, THOMAS, 6** Blake Street, Middlesbrough. —Improvements in couplings for railway carriages and trucks and other vehicles.

664. **WINTER, MERIGOT, & FROST, 56** Conduit Street, Regent Street, London, W. —(1) Improvements in wheels and axles for railway, tramway, or other rolling stock. (2) Apparatus for raising and lowering windows of railway and other carriages. (3) Suspension Roller Covering for tramcars and omnibuses.

666. HALL, JOHN JAMES, Upton, Slough, Bucks.—Train Communicator, or Day and Night [detonating, disc, and red light] Alarm Signal. Communication between passenger, guard and engine driver.

667. ELECTRIC SIGNAL CO., Limited, 62 Hogarth Road, West Kensington, London, S.W.—A System of Railway Signalling. According to this system the ordinary visual signals are repeated on the engine, and as long as the semaphore is set at danger an audible signal also is maintained on the engine. This is effected either by making or breaking an electric circuit. The progress of the train along the line is indicated to the signalman, and the duration of each danger signal is automatically recorded. When the train rests on the line any message may be sent to or from it.

668. TURNBULL, LIEUTENANT-COLONEL J. R., The Priory, Torquay.—System of calling attention of guard and engine driver in railway carriages.

669. NATT, JAMES, 35 South Molton Street, Oxford Street, London, W.—Apparatus for placing fog signals in position on railways. Suitable for long distances, and blocking line, and can be worked with semaphore.

BETTLEY, J. H., 42 Old Broad Street, E.C.—(1) Duplex Universal Money and Account Check. (2) Road and Railway Starter. (3) Inner Flange Brake. (4) Improved Springs. (5) Auxiliary Car Starter.

SAUNDERS, LAWRENCE, 2 Victoria Mansions, Westminster, London, S.W.—(1) Whiteman's Automatic Check System of Railway Signalling. (2) Meakin Tram Rail. (3) Model of Darling's Railway Carriage and Wagon Couplings for the preservation of life by enabling the operations of coupling and uncoupling to be performed without going between the vehicles.

WISE, CHARLES, 29 Harvel Terrace, Willow Walk, Bermondsey, London, S.E.—Compensating Apparatus for long lengths of working signal wires. To counteract expansion and contraction caused by variation of temperature.

BRIERLEY & CO., 21 Sixth Avenue, Queen's Park, W.—(1) Railway Safety Appliances. (2) Champagne Stand. (3) Improved Appliances for working railway points and signals.

DAVIES, ISHMAEL, Derby Villas, Amherst Street, Brook Road, Fallowfield, Manchester.—Patent Railway Wagon Coupling.

COLQUHOUN, JOHN, 1 Royal Terrace, Edinburgh.—Automatic Continuous Brake.

BROCKELBANK, HENRY, 4 Old Jewry, London, E.C.—Models illustrating patent momentum railway brake and combined strictly absolute block system as fitted to passenger and goods stock.

BROCKELBANK, T. ATTWOOD, 34 Rylett Road, Shepherd's Bush, London, W.—Automatic Railway Couplings. The alteration from manual coupling as it now exists to automatic action can be done on wagons whether loaded or light and of every description in any shunting yard in half-an-hour, leaving the drawhook to be used with chain coupling on emergency.

POWELL, THOMAS T., James Street, Harrogate.—Powell's Patented Apparatus for signalling on railways by means of electricity or magnetism, between the passengers and attendants of a train while in motion; and also to signalmen at the signal-cabins, localising the position of a train within a block, so that the signalman may always know the exact position of a train approaching him.

PARES, T., Aston Terrace, Bromsgrove.—Patent Coupler, for coupling and uncoupling railway wagons and trucks, and thus avoiding the shunter getting in between the buffers.

STEELE, JOHN, Chelmsford, Essex.—Railway Platelayers' Signal of approaching trains.

AUTOMATIC APPARATUS CO., Limited (THE), 16 Rue Bleue, Paris (Agent, A. MACKIE, 19 Hop Exchange, London, S.E.), (COMPAGNIE DES APPAREILS AUTOMATIQUES POUR ACCROCHER LES WAGONS DE CHEMIN DE FER).—Apparatus for coupling and uncoupling railway carriages and trucks. (See Outside, South Promenade.)

TIMMIS, I. AUGUSTUS, 2 Great George Street, Westminster, London, S.W.—Improvements in Electro-Magnets, working, locking and interlocking of Railway Signals and Points, and Railway Brakes. (See Outside, South Promenade.)

SOUTH-EASTERN RAILWAY GENERAL MANAGER'S OFFICE, London Bridge Station, London, S.E.—Goods and Coal Wagons constructed so as to be run at express speeds. (1) Is a wagon of the type now being built by the South-Eastern Railway Company at their Ashford Works for carrying goods and general merchandise at the maximum rate of speed. This wagon is furnished with wheels and axles similar to carriages, axle boxes for oil or grease, india-rubber buffer

draw springs, screw coupling and safety pins. (2) Is another type of wagon built by the South-Eastern Railway Company to travel at maximum speed, for the conveyance of coal & goods. This wagon is furnished in like manner to the last-named. (See *Outside, South Promenade*.)

CASHER PATENT RAIL JOINT CO., Limited (THE), Castle Court, Sheffield. (See Group III.)

ALLIN, S. SEALY, 12 Woodstock Road, Bedford Park, Chiswick, London, W. (See Group IV.)

APPLEBY BROS., 89 Cannon Street, London, E.C. (See Group XI.)

ASKHAM BROS. & WILSON, Limited, Yorkshire Steel & Engineering Works & Crucible Foundry, Sheffield. (See Group III.)

AVERY, W. & T., Digbeth, Birmingham; and 14, 15 & 16 Cow Cross Street, London, E.C. (See Group XI., *Queen's Gate Annexe*.)

BATHO, W. F., 9 Victoria Chambers, Westminster, London, S.W. (See *Inside, South Promenade*.)

BOYD, H. P., Iron Manufacturer, Southampton. (See Group XXIV.)

BROWN, J. D., & CO., 49 Fenchurch Street, London, E.C. (See Group III.)

BROWNLEE & CO., City Saw Mills, Dundas, Glasgow. (See Group III.)

BUCKLEY, W. & CO., Patent Piston Mills, Milsands, Sheffield. (See Group III.)

CARPENTER, JAMES, 20 Dorset Street, New Town, Southampton. (See Group VII.)

CLARK & STANFIELD, 6 Westminster Chambers, London, S.W. (See Group III.)

MCLOUGH, J. E. H., 22 & 23 Fleet Street, Dublin. (See Group VI.)

COASDELL, S. T., Barr's View, Carlisle. (See Group III.)

DAVIDSON, C. E., 7 Nevern Road, London, S.W. (See Group XXVI.)

AIRLIE ENGINE & ROLLING CO. (THE), Palace Chambers, Westminster, London, S.W. (See Group III.)

FOOLEY, HENRY, & SON, Albion Foundry, Liverpool. (See Group XI., *Queen's Gate Annexe*.)

FOX, EDWIN, & CO., Limited, Magnetic Telegraph Wire Works, Millwall, London, E. (See Group XIII.)

HARDY PATENT PICK CO., Limited, Sheffield. (See Group II.)

HINDSON, WM., 3 Claremont Park, Gateshead-on-Tyne. (See Group III.)

HOWARD, J. & F., Britannia Iron Works, Bedford. (See Group I.)

HYDRAULIC ENGINEERING CO., Limited (THE), Palace Chambers, Westminster, London, S.W. (See Group XI.)

JACKSON, J., 8 Frederick Place, Gray's Inn Road, London, W.C. (See Group IV.)

JELLY, SON, & JONES, 196 Blackfriars Road, London, S.E. (See Group XXIV.)

JENKIN, F., 3 Great Stuart Street, Edinburgh; and 53 Old Broad Street, London, E.C. (See Group XIII.)

KAYE, JOSEPH, & SONS, Patent Lock Works, South Accommodation Road, Leeds; and 93 High Holborn, London, W.C. (See Group XXIV.)

KINETIC ENGINEERING CO. (THE), 36-37 Brooke Street, Holborn, London, E.C. (See Group XIII.)

LEADBEATER, SAMUEL, Machine Maker, Morley, near Leeds. (See Group III.)

MUNICIPAL APPLIANCES CO., Limited, 37 Victoria Street, Liverpool. (See Group III.)

PATENT (METAL) DIE CO., Limited (THE), 29 Addington Street, York Road, London, S.E. (See Group XI.)

PATENT NUT & BOLT CO., Limited (THE), London Works, near Birmingham. (See Group III.)

PHOSPHOR BRONZE CO., Limited, 87 Sumner Street, Southwark, London, S.E. (See Group II.)

QUARMBY, J., 149 High Street, Oxford Road, Manchester. (See Group III.)

RICHTER PATENT ECONOMISER MANUFACTURING CO. (THE), West End Mills, Longside Lane, Bradford. (*See Group IV.*)

SHARP, STEWART, & CO., Limited, Atlas Works, Manchester. (*See Group XI.*)

TERRANEAU, C. G. E., 3 Circuit Place, Finsbury, London, E.C. (*See Group VI.*)

TERRELL, W., & SONS, Welsh Back, Bristol. (*See Group IV.*)

TRAILL, W. A., Giants' Causeway Electric Tramway, Portrush, Co. Antrim. (*See Group XIII.*)

TYLER, HAYWARD, & CO., 84 and 85 Whitecross Street, London, E.C. (*See Group II.*)

URQUHART, ROBERT L., 3 Lauder Road, Edinburgh. (*See Group III.*)

WETHERED, LIEUT.-COL. E. R., 100 Herbert Road, Woolwich, Kent. (*See Group XXIV.*)

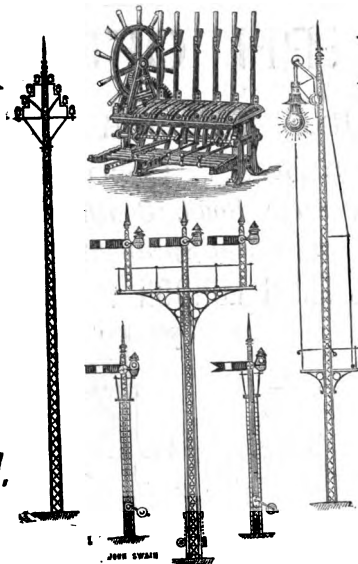
WITHEY, E., & CO., Middleton Shipyard, West Hartlepool. (*See Group III.*)

WORSSAM, S., & CO., Oakley Works, King's Road, Chelsea, S.W. (*See Group X.*)

YOUNG, C. S., 90 Wells Street, Lozells, Birmingham. (*See Group VII.*)

Highest Award
of Merit,
Sydney, 1880.

London Offices:
61, Sinclair Rd.
W.



Highest Award
and
Gold Medal,
Calcutta, 1884.

London Offices:
61, Sinclair Rd.
W.

McKENZIE AND HOLLAND,

Railway Signal Engineers,

WORCESTER.

The above are Patentees and Manufacturers of an Improved Patent Apparatus for Working and Interlocking Railway Points and Signals, whereby all conflict between Points and Signals is entirely prevented, and absolute safety in working produced. Upwards of 40,000 Levers are now in daily use on all the principal Railways of the United Kingdom and the Colonies.

McKENZIE AND HOLLAND believe their Invention to be the most efficient in working and the cheapest in point of maintenance, many hundreds of their Locking Frames having been in operation for years without entailing any expense in repair, being now as good and efficient as when they were originally fixed.

Sole Manufacturers of Fisher's Patent Improved Facing Point-detector Lock, worked in connection with their Apparatus.

Makers of Railway Signal Cabins or Huts, either of Timber, Stone, or Brick.

Level Crossing Gates with Sympathetic Action adaptable to all Crossings fitted with Patent Self-Catching and Locking Stops.

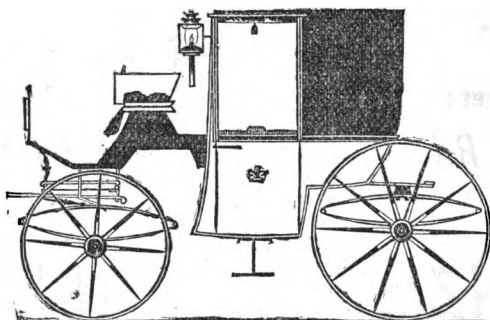
Railway Signals of all descriptions, either of Timber or Iron, with Improved Balanced Arms.

Fittings and Ironwork of all descriptions necessary for the working of Points and Signals on Railways. Electric Light Standards, etc., etc.

JOSEPH OFFORD,
COACHBUILDER and HARNESS MAKER,
 67, George Street, Portman Square ;
 92 and 94, Gloucester Road, South Kensington, London.
ESTABLISHED 1790,
24 PRIZE MEDALS FROM LONDON 1851 TO CALCUTTA 1883.

To H.H. the
 Viceroy of Egypt,
 and to the
 Mikado of Japan.

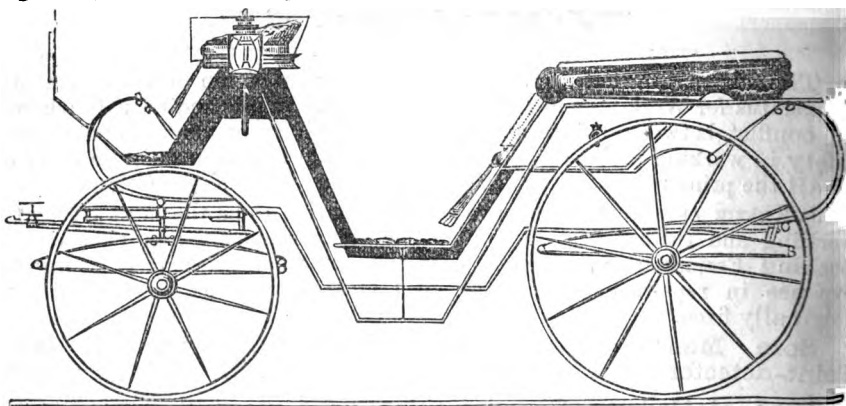
*Carriages sold on
 the Three Years'
 Hire System.*



To the Emperor
 of Germany,
 and to the
 King of Spain.

*300 Carriages of all
 descriptions, New
 and Secondhand, in
 Stock.*

SOLE Maker of the celebrated Bijou Coupés, hung on Patent Silent or Cee Springs, as shown in Queen's Gate Annexe. The lightest, easiest, and most elegant of Miniature Broughams. All Colours kept in Stock.



SPECIALITÉ.—Carriages suspended on Cee and Under Springs, and with light Steel Perches, combining comfort, ease, and elegance with the minimum of weight.

Parties preferring to hire their carriages by the year or term of years, will find it a most convenient arrangement. The payments include all necessary repairs. Arrangements can be made to purchase any carriage taken on hire by equal annual payments.

REPAIRS OF EVERY DESCRIPTION. ESTIMATES FREE.

PATENTEE OF RUBBER BRAKE SKIDS, TYRES, STEPS, &c. &c.

Send or apply at Stand in Queen's Gate Annexe for Catalogues and Price Lists.

GROUP VI.—COMMON ROAD CARRIAGES, &c.**NORTH OF QUEEN'S GATE ANNEXE.**

[For Farm Wagons, &c., see Group I.]

670. OFFORD & SONS, 92 Gloucester Road, South Kensington, London, S.W.—(1) Angular Landau, with open steel boot. Fitted with Offord's patent self-acting hood, headlocks, india-rubber covered steps, springs, axles, rubber roller bolts and perchbolt. (2) O Spring Victoria, with arched perch. Fitted with Offord's patent steps and roller bolts; mountings of Webster's patent metal. (3) Miniature Single Brougham. Fitted with novel arrangements for ventilation and lighting. Offord's patent steps and india-rubber tires. (4) Offord's Patent India-rubber Brake Skids, Rubber-covered Steps, and Roller Bolts, Patent Axles, Springs, Wheelplate, Perchbolt, Landau Head Lift and Headlocks, Wheels, &c., and various improvements in carriages.

671. ATKINSON & PHILIPSON, Newcastle-on-Tyne.—(1) Landau, fitted with patent head fittings, Philipson's patent window fittings, a new electric bell, &c. (2) Whitechapel Dog Cart with novelty in springs, method of balancing, tufts to cushions, &c. (3) Philipson's Stretcher Couch, convertible into a chair or stretcher. (4) Double and Single Harness, made on the humane principles. (5) Specimen axles by Sydney Lawson & Co., and drawings of new designs and improvements.

672. BROCKELBANK, HENRY, 4 Old Jewry, London, E.C.—Model of Improved Hansom Cab, fitted with patent combination weather shield and safety window, obviating the necessity to close the cab in wet weather; also fitted with improved rein-bearer, for enabling the driver to shift the reins clear of the passenger entering or leaving the vehicle.

673. MORGAN & CO., 128, 129 Long Acre, W.C.—Patents and improvements in carriages, landau, brougham, victoria, buggy, special opening brougham.

675. ANDREWS, E. & A., Winchester.—(1) Improved Shaped and Lightly Constructed O Spring Single Brougham, with Warner Patent Wheels and Self-acting Patent Steps and Break. (2) A Victoria, hung on improved O springs and leather braces, patent balance head.

676. ALLEN, J. & F., 29 Long Acre, London, W.C.—(1) Combination O and Under Springs for carriages utilizing the elasticity of the entire length of the O spring and cutting off vibration by open looped flexible leather braces without need of a perch. (2) Rubber Centred Wheels. (3) Registered Buggy Spring.

677. HOOPER & CO., 113 Victoria Street, London, S.W.—(1) Park Phaeton, more compact, higher front wheels, new spring balance action to hood. (2) O Spring Single Brougham, on a wrought iron perch, invented by the Exhibitors. The interior has a new convenient sliding writing tray. (3) Sefton Landau for one horse, a light, commodious, compact carriage for four persons, patent balance spring action to hood, india-rubber tires to wheels. Whitworth's new system of interchangeable axle boxes and fittings is applied to these and all carriages built by the Exhibitors.

678. BOTWOOD, WILLIAM, Woodbridge Road, Ipswich.—(1) Victoria, with Improved Patent Head. (2) Dog Cart, with Botwood's Patent Shafts. (3) Wheel, with Botwood's Patent Step to Axle.

679. AVES, W. O., 46 Barbican, London, E.C.—(1) Wheels having unseen rubber tires enclosed by a weldless ring of steel which forms the wearing tire. Being of arched shape they act as an instantaneous spring, and effectively check vibration.

680. HOLMES & CO., 38 Margaret Street, London, W.; and Derby, Lichfield, and Sheffield.—(1) A Light Doctor's Brougham, with patent springs, wheels, india-rubber tires, and the V. W. H. [Gausson's Patent] india-rubber insulating spring seat cushions. (2) A Patent Adjustable Dog Cart, with the V. W. H. patent india-rubber cushions, back rests, mats, &c. (3) A Set of Single Harness, and a Riding Saddle, with the V. W. H. patent india-rubber lining to the saddles and collar. (4) Holme's Patent Bracketed Axle. (5) Improved Frost Chisels for roughing horses in frosty weather.

681. HAMSHAW, W. H., Patent Carriage Works, Wimbledon, Surrey.—Cosy Cart, with patent axle, hind folding step, and rubber covered treads to front steps, perfect balance with a light or heavy load, adjustable shafts and movable hind seats to give luggage room.

682. CLIFT & SON, The Excelsior Carriage Works, Wellington, Shropshire.—The Excelsior Patent Combination Carriage, forms both a four and two wheeled vehicle, and can be arranged as a *vis-à-vis* phaeton, a dog-cart phaeton, or an Alexandra car.

683. BURN & CO., 25 Wigmore Street, London, W.—Floyd's Patent Cabs.

684. WELCH, E. J. COWLING, Palace Chambers, Bridge Street, Westminster, London, S.W.—Patent Weather Shade for hansom cabs; capable of being applied to any existing hansom cab.

685. ALLEN, E. E., 111 Cheyne Walk, Chelsea, London, S.W.—(1)

Patent Saloon Hansom Cab. (2) Model of Brougham. (3) Hansom Cab, capable of being converted into ordinary brougham by removal of dickey and addition of fore carriage. (4) Model of Improved Tricycle.

686. FORDER, ALFRED, & CO., Lonsdale Coach and Harness Factory, Wolverhampton.—Improvements in Hansom cabs.

689. MORGAN & CO., 128, 129 Long Acre, London, W.C.—Private Hansom Cab.

690. MARSTON, JOHN, & CO., 21 to 26 Bradford Street, Birmingham.—(1) The Patent Imperial Brougham Hansom, which forms an open or closed carriage. (2) The New Patent Balancing Brougham Hansom, forms an open or closed carriage, can be driven from the inside or outside, yet perfectly balanced without any counter weight.

691. BANKS, GEORGE CAMERON, 9 South Saint Andrew Street, Edinburgh.—Victoria Opening Hansom [Johnstone's Patent], showing a folding roof, and interchangeable in three distinct forms.

692. ABBOTT & CO., Torridge Works, Bideford, Devon.—New Patent Four-Seat Devon Hansom Cab. This two-wheel cab is offered as a substitute for the ordinary four-wheeler, as it carries four passengers and luggage with same speed and comfort as an ordinary Hansom, whilst the draught for horse and dead weight are but little in excess of that vehicle.

693. FORDER & CO., Limited, 7, 8 & 9 Upper St. Martin's Lane, London, W.C.; and Wolverhampton.—(1) Private Hansom, finished in best style, hung upon Forder's Patent C spring, and fitted up with Forder's Patent Glass Frames. (2) Public Hansom, finished in best style, fitted up with Forder's Patent Glass Frames.

694. MAYTHORN, JOHN, Coach Works, Biggleswade, Beds.—(1) Victoria, convertible to Park Phaeton, hung on C spring without a perch, which embraces the elegance and comfort of a Cee and under-spring suspension with the lightness of an elliptic spring carriage. Fitted with self-adjusting head. (2) Improved One-Horse Canoe Landau, with self-adjusting head, giving ample room for four persons inside, whilst quite light enough for one horse.

695. KING, WILLIAM, Battlesden Steam Carriage Works, Leighton Buzzard.—Battlesden Car and Tandem Dog Cart, with screw shifting apparatus and automatic brake.

696. THRUPP & MABERLY, 425 Oxford Street, London, W.—(1) Small

Single Brougham, with our patent sans Brui wheels. (2) New Siamese Victoria, with our patent C springs behind.

697. WINDOVER, C. S., 154 Piccadilly, London, W.; and Huntingdon.—(1) Huntingdon Cee Spring Buggy, with patent cross spring and india-rubber bearing, new design. (2) Victoria, with patent self-acting automatic head, hung on Cee springs without perch.

698. WORGER & SON, 8 Belgrave Mansions, Pimlico, London, S.W.—(1) Automatic Action as applied to glass frames of carriages. (2) Suspension of Carriages on C springs without perch.

699. PERRY & CO., Stokes Croft, Bristol.—Special Circular-fronted Brougham Wagonette, fitted with their patent improvement in the construction of covered wagonettes and other closed carriages for the purpose of ventilating.

700. McMULLEN, H., & SON, North Crescent, and Castle Street, Hertford.—(1) The Crescent Car. (2) The Crescent Phaeton.

701. McNAUGHT & CO., Worcester, Liverpool; and 10 Park Lane, London, W.—(1) Five-Glass Landau with automatic parallel movement. (2) Princess Victoria on C and under spring carriage. (3) Single Brougham on C and under springs.

702. COOK & CASSON, Malvern Link.—A Brake for two-wheeled vehicles, which takes weight off the horse and places the body of the vehicle level when going down hill.

703. CARPENTER, WILLIAM, High Street, Staines, Middlesex.—Improved method of balancing dog-carts.

704. MULLINER, FRANCIS, Brook Street, London, W.; and Bold Street, Liverpool.—(1) Beaufort Brougham. (2) Tilbury Plan of underworks to carriages. (3) Oliver Dog Cart.

705. POWELL, JOHN, St. Columb, Cornwall.—Improvements in the balancing of two-wheeled vehicles, and also in the construction of wheels for common roads.

706. NEWNHAM, B., Monmouth Place, Queen's Square, Bath.—(1) The Ladies' Patent Step. (2) Improved Carriage Lift for raising the axles or body of carriage. (3) Improved Road Carriage or Cab.

707. BROCKELBANK, R. H., 30 Islington Green, London, N.—(1) Registered Quick Shifting Wagonette. (2) Stanhope phaeton, with folding step in the tail-board, and dividing front seat with self-acting lock and patent shaft holders. (3) A

Light One-horse Landau, with an improved
 carriage to bring the wheels closer together.
 (3) Patent Self-acting Step Covers and Patent
 Shaft Holders.

708. HART, SAMUEL, 79 New Bond
 Street, London, W.—(1) Patent Nikéma
 Landau, C and under spring without perch,
 patent balanced head and folding steps. (2)
 Patent Thagma Wagonette, with sliding seats
 and folding step. Reversible to Stanhope
 Phaeton.

709. THORN, CHARLES, St. Giles'
 Lane, Norwich.—(1) Patent Adjusting
 Fittings to shafts. (2) Patent Automatic
 Seat for wagonette or Stanhope phaeton. (3)
 Patent Automatic Double Folding Step. (4)
 Patent Automatic Balance Heads for landaus
 without outside joints. (5) Patent Automatic
 Balance Fittings for victoria or barouche heads.
 (6) Newly Invented C and Under-spring System
 for hanging carriages with two perches.

710. RICHARDS, G. B., 26 Sand-
 brook Road, Stoke Newington, London,
 N.—Automatic Brake for road vehicles, with
 buffer attached.

711. TODD & WRIGHT, 34 Craven
 Road, Hyde Park, London, W.—Patent
 Whinstone Travelling Car and Improved Dog
 Cart, for one or two horses driven as currie.

712. WILLIAMSON, W. E., 22 East-
 burne Road, Stamford Hill, London,
 N.—Improved Stage Carriage, with apparatus
 for registering fares.

713. MORTIMER, W. R., 2 Great
 Portland Street, London, W.C.—Brougham,
 with Mortimer's patent brake, electric
 bell and communication with the coachman;
 fitted with electric door indicator and
 rubber tires.

714. BARTON, J., & SONS, Carriage
 Works, Quay Head, Bristol.—Stanhope
 Wagonette, reversible with improved steel front
 spring, combining lightness, strength, and
 flexibility.

715. LAWTON, J. A., & CO., 35
 Man Street, Liverpool.—Patent
 C and Under Spring Victoria Phaeton.

716. LLOYD, HENRY, 12 Colquit
 Street, Liverpool; and 162 Queen's
 Bayswater, London, W.—(1)
 Patent Two and Four Wheel Folding
 Carriages, changed instantly from two
 wheels to four, and *vice versa*. (2) Two-Wheeler,
 with pole and bars for a pair of horses.

717. MULLINER, H., & CO.,
 10, Northampton and Leaming-
 Street, London.—(1) Brougham, fitted up with patent
 rubber collars to the axles, and several
 other important inventions. (2) Emperor

Phaeton, fitted up with patent india-rubber
 collars to the axles, a lined step moving with
 seat, &c.

718. LUCAS, F. W., 451 Oxford
 Street, London, W.; and Brixton Hill,
 London, S.W.—Improved Methods in manu-
 facture and finish of road carriages, viz. open-
 ing of heads, fittings of lever break, body, steps,
 &c., patent vibration insulators, and artistic
 designs in decorations, both for the interiors
 and exteriors.

719. FULLER, S. & A., Bath.—(1)
 Patent Glass-fronted Landau, opened and
 closed from the driver's seat. (2) The Plexo-
 rophu Wagonette, forming a light open or close
 carriage at pleasure. (3) The Bijou extra
 light landau, constructed on new plan for ob-
 taining lightness of draught without curtailing
 inside accommodation.

720. BRISTOL WAGGON WORKS
 CO., Limited (THE), Lawrence Hill,
 Bristol.—(1) Margetson and Hek's Patent
 Screw Tip Cart. (2) Margetson's Patent Water
 Van. (3) Margetson's Patent Balancing Water
 Cart. (4) Margetson's & Hek's Patent Tip
 Wagon.

722. SARGEANT, T. C., 22 Horse-
 market, Northampton.—A Combined
 Balancing, Tipping and Automatic Fastening
 Attachment to Carts, &c.

723. HAYES & SON, Stamford,
 Lincolnshire, and 199, 201 City Road,
 London, E.C.—Watling's Patent Tip Van or
 Wagon, designed for the conveyance of street
 sweepings, coals, lime, agricultural produce and
 general merchandise.

724. BARRETT, H. J., 16 High
 Street, Hull (Agent, J. HUMPHRYS,
 Leadenhall Buildings, London, E.C.)—
 Patent Colonial Transport Wagon and Military
 Wagons, specially adapted for tropical climates
 and the roughest roads, from their strength,
 flexibility and durability. The wheels are
 constructed entirely of metal, the spokes can be
 readily taken out and replaced, and tyres
 and axle bushes renewed by unskilled work-
 men. Can be packed in small compass for
 shipment.

725. HILL, CHARLES, 30 Peckham
 Park Road, London, S.E.—Patent Self-
 acting Tip Van.

726. BRIGGS, T., Bridge Street
 Patent Cart Works, Darwen, Lancashire.—Patent Adjustable Car and Noiseless
 Automatic Brake, which takes all the weight
 off the horse's back, and effectually applies the
 brake when going down hill, or reversing the
 same handle puts an unlimited weight on the
 horse's back when going up hill without apply-
 ing the brake.

727. VINCENT, WILLIAM, Arborfield, near Reading, Berks.—(1) Vincent's Patent Tip Cart for farm and road. (2) Vincent's Patent Roofing Tiles. (3) Vincent's Patent Tiles for facing inside of walls; can be fixed to wood battens as on roof; easily fixed without nails.

728. SCOTT, W., Bath Wheel Works Co., Broad Street, Bath.—Improvements in vehicles for the conveyance of bread, meat, milk, groceries, &c.

729. WEBB & SONS, 44 Holland Street, Southwark; and 38 Albert Embankment, London, S.E.—(1) Light Covered Van. (2) Light Retail Milk Van.

730. SINGERS & CO., Coventry.—Parcels Post Perambulators and Parcel Carriers.

731. CARTER, JOHN, 6a New Cavendish Street, Portland Place, London, W.—(1) A Bath Chair and a Perambulator having automatic walking action for exercising the legs and feet, fitted with the V. W. H. patent india-rubber insulating double spring cushion. (2) A Perambulator fitted with a V. W. H. patented corrugated rubber mattress.

732. VIPAN & HEADLEY, Church Gate Agricultural Implement Works, Leicester.—Leicester Combination Milk Cart, with swinging cans for retailing milk and other dairy produce.

733. READING, A., 24 King's Road, Southsea.—Improved means of raising and lowering shafts of two-wheel pony carts to balance for any height.

734. HARVIE, A., 19 St. John Street, St. Peter's Street, Islington, London, N.—Improved means for contracting perambulators and wheel chairs.

735. JOHNSON, JOHN, 87 New Oxford Street, London, W.C.—New and improved forms of perambulators.

736. ANDREWS, E., 5 Market Hill, Sudbury, Suffolk.—Automatic Brake for bath chairs, perambulators, &c.

737. DUNNETT, ROBERT, Cobden House, High Street, Camden Town, London, N.W.—Patent Folding Cot Carriage, Bassinets, Invalid Chairs, Spinal Carriages, and Perambulators of every description.

738. HITCHING, T. H. BROOKE, 23, 21, 19 Ludgate Hill, E.C.; and 116 Oxford Street, London, W.; Liverpool and Brighton.—(1) Baby Carriages, with patent safety brake and patent detachable ariel wheels. (2) Patent Combination Baby Chairs. (3) Patent Baby Walker.

739. HATCHMAN, WILLIAM, & CO., 73, 74 Wood Street, London, E.C.—Improvements in perambulators.

740. LEE, G. P., Vernon Works, Longsight, Manchester.—Improvements in the construction of perambulator bodies, being made of fluted steel of great lightness combined with strength.

741. SIMMONS & CO., 21, 22 Railway Approach, London Bridge, London, S.E.—Patent Bear Steering Invalid Carriages and Patent Steering Perambulators.

742. PARKER BROTHERS, 104 to 110 Curtain Road, Shoreditch, London, E.C.—Improvements in Bassinette, Infant Carriages, and Perambulators.

743. TERRANEAU, C. G. E., 8 Circus Place, Finsbury, London, E.C.—Improved Fastener or Catch, applicable to railway and other carriage windows and doors.

744. TOWNSEND, H. R., 100 St. John Street Road, Clerkenwell, London, E.C.—Patent Safety Wheel Tires for common road carriages. To prevent skidding when crossing tram rails.

745. WILSON, J. E., Rosedale Villa, Leytonstone.—(1) Improved construction of wheels. (2) Road Carriage for one or more horses. (3) Tricycle.

746. HELY, WILLIAM, 3 Alexander Buildings, Bath.—The Hicknut Patent Self-acting Head Lift.

748. CANE, RICHARD, 65 Dean Street, London, W.—The Universal Folding Cot [Cane's Patent].

749. HARRISON, R., & SON, Stanhope Street, Euston Road, London, N.W.—Landau in the skeleton, showing the action of R. Harrison & Son's climax radius head-lifts, for opening and closing the hoods of carriages. The lamps lighted by electricity.

750. INSTITUTE OF BRITISH CARRIAGE MANUFACTURERS (THE), 16a Great Queen Street, London, W.C.—Improvements in the manufacture of carriage parts.

751. BROOKS, ROBERT, 8 Symond Terrace, Grenville Road, Hornsey Road, London, N.—Boat Carriage for land and water.

752. BIRD, F., & CO., 11 Great Castle Street, Regent Street, London, W.—Improvements in india-rubber tires for carriages, invalid and Bath chair, and ambulance wheels for the prevention of noise, and securing ease and comfort to the riders.

753. DAKERS, JAMES, 7 Union Wynd, Aberdeenshire.—Axles and Springs for carriages.

74. CORTEEN, WILLIAM, 41 North Church Street, Sheffield.—(1) Improvements in and relating to carriage brake apparatus. (2) Improved method of opening and closing windows of any description.

75. BAKER, J. L., & CO., Cockatrice Works, Hargrave, near Kimbolton, Huntingdonshire.—(1) Improved Patent Oven for heating tires and other articles. (2) Patent, Self Acting, Sinking Platform, for tiring wheels, with tank complete.

757. MARTIN, WILLIAM, 19 Silver Street, Manchester.—Improved Noiseless Wheel, constructed of metal with blocks of hard wood fixed grain end up.

758. STANLEY, F., 6 Clifton Gardens, Margate, Kent.—Combined Carrying Chair or Stretcher.

759. WOOLNOUGH, C., 2 Elizabeth Street, Eaton Square, London, S.W.—Improvement in carriage fittings to facilitate immediately releasing the horse or horses from a carriage or other vehicle, in cases of accident or otherwise.

760. WESTAWAY, JAMES, Coryton, Lewdown, North Devon.—(1) The Guidance Lamps for carriages, fire-engines, tricycles. (2) The Martinet Reins for riding and driving.

761. COLCLOUGH, J. E. H., 22, 23 Duke Street, Dublin.—(1) Noiseless Axle. (2) Spring Lock for carriage doors. (3) Double Action Fore Carriage for carriages.

762. HALL, JOSEPH, Wharnccliffe Chambers, Sheffield.—Model of the Patent Hall Bicycle.

763. FRY, SAMUEL, Sompting, Watley Terrace, Fitzjohn Avenue, London, N.W.—Safety Bicycle Saddle.

764. PERRY, H. H., 6 Friends Road, East Croydon.—Central Double Driving Gear for tricycles.

765. CHALLIS & CO., Orchard Buildings, Haggerston, London, E.—Patent Stop and other Bells for use on bicycles, tricycles, sledges, &c.

766. LEVESON & SONS, 90 & 92 New Oxford Street, London, W.C.—(1) The Metalicon Perambulators. (2) The Khartoum Perambulators. (3) Improved Bath Chair on C springs, for hand or pony. (4) The Victoria Invalid's Carriage.

767. NEEDHAM, G. H., Cologne Road, New Wandsworth, London, S.E.—Perambulator Patent.

768. ROBSON, JAMES, 20 London Street, Fitzroy Square, London, W.—Folding Perambulators.

770. RAMSEY, F. A., 135 Fenchurch Street, London, E.C.—The Gemini or Twin Bicycle, for two riders.

771. ROBERTS, FREDERICK, Cross Ways, Lower Beeding, Sussex.—Improvements in Velocipedes.

772. CAPITAL & LABOUR CO. (THE), (HOLLOWAY BROS.), 157 Westminster Bridge Road, S.E.—Tricycle Patent.

773. WARMAN & CO., 16 Stephen Street, Coventry.—Patent non-stretching pitch chains and improvements in wheels for same. Applicable to tricycles and all classes of machinery where a perfect non-stretching pitch-chain is required.

774. HARRISON, J., Kensington Works, Kensington Street, Birmingham.—(1) Bicycle and Tricycle Bells. (2) Lamps. (3) Saddles. (4) Valises. (5) Oil Cans. (6) Whistles. (7) Locks and Chains. (8) Cyclometers. (9) Bearings. (10) Bearing Balls. (11) Spoke Tighteners. (12) Wrenches. (13) Stampings and Fittings. (14) Ship Lamps. (15) Table Bells. (16) Carriage Step Stampings.

775. DUNN, THOMAS, 48 Threadneedle Street, London, E.C.—The Ordnance Odometer, an improved distance indicator, which, besides several other advantages, is adjustable to the exact size of any wheel, so as to give accurate measurements, recording clearly every turn of the wheel, giving a continuous record, as well as a daily or temporary one.

776. MAYNARD, HARRIS & CO., 126 & 127 Leadenhall Street, London, E.C.—Imperial Devon Tricycle, fitted with latest improvements, including the Swing Frame for hill riding, two powerful brakes and new way of applying band brake, double driving balance gear and ratchet action combined, &c.

778. SIMONTON, JOHN, Comber, Co. Down, Ireland.—Monocycle or Unicycle, a one-wheeled velocipede.

779. SMITH, W. B., 14 Dale Street, Leamington.—(1) Improved Construction of Bicycles and Tricycles, Balance Gear, Saddle Spring, and other cycle fittings. (2) The Combination Cycle, comprising Front-Steering Tricycle and Improved Safety Bicycle, combined as a Tandem, but detachable.

780. REEVES, THOMAS, 145 Finlay Drive, Glasgow.—Patent Tricycle, with new cranked axle, minimising vibration and reducing weight in these machines.

781. PROPELLER BICYCLE AND TRICYCLE CO. (THE), King Street Works, Coventry.—(1) Improved Patent

Disconnecting Mechanism of Two-track Tricycles, for allowing the pedals to be stationary when descending hills. (2) Improvements in or connected with tricycles and other analogous vehicles.

782. MARKHAM & CO., 345 Edgware Road, London, W.—The Eccentric Tricycle, having improved machinery for avoiding dead points when obtaining rotary motion by the action of two forces on different cranks [Shann's Patent].

783. KELSEY & KELSEY, 9 North Western Arcade, Birmingham.—(1) Ventilated Handles for bicycles and tricycles. (2) Patent Safety Bicycle.

784. JOHNSTON & HIGH, 82 Boyson Road, Walworth, London, S.E.—New Merlin Tricycle and Bicycle, fitted with lever action and disconnected treadles.

786. HERNU, A. H., 1 Baron's Court Chambers, West Kensington, London, S.W.—Improved Apparatus for measuring the distance travelled by bicycles, tricycles, &c., consisting of a cyclometer mounted on a Hub lamp and driven by means of a worm fixed to the axle. The meter can also be used without a lamp.

788. BOWN, WILLIAM, 308 Summer Lane, Birmingham.—(1) Patent Tricycles, Bicycles, and Newmarket and other Horse Clippers. (2) New Motor attached to and driving a sewing machine.

789. BEVAN, WILLIAM, 66 Florence Road, New Cross, London, S.E.—Improved Bicycle Safety Attachment for learners.

789. TAYLOR, J. M., & G. WETH-ERED, Seer Green Vicarage, Beaconsfield.—Oarsman Tricycle.

790. RUDGE, D., & CO., Coventry.—(1) Rotary Tricycles. (2) Bicycles. (3) Detachable Cranks. (4) Speed and Power Gear. (5) Tangent Wheels. (6) Ball Bearings.

791. HOLLINS, E. H., 147 Walworth Road, London, S.E.—(1) International Land and Water Travelling Machine. (2) A Water Cycle. (3) A Vacuum Spring Tension Centre Piece for the Use of Wheels. (4) A Wheel that will lay its own rail.

792. HILLS, G. J., Twyford, Berks.—The Safer Tricycle.

793. COOKSON, F. N., Waterloo Road, Wolverhampton.—(1) Improved Tricycle. (2) Improved Bearing for bicycles, &c.

794. BIRMINGHAM SMALL ARMS CO. (THE), (Agent, E. W. ANDREWS,

6 Great Winchester Street, E.C.)—Improvement in Bicycles.

795. ADIE, P., Broadway Works, Westminster, S.W.—(1) Machinery for edging grass. (2) Velocipedes.

796. CAROHE TRICYCLE CO. (THE), Much Park Street, and Jordan Well, Coventry.—Patent Improved Gearing for tricycles.

797. BROOKES, J. & H., Cap Works, Birmingham.—(1) Convertible Rear Steering Tandem Tricycle; may be used as a single machine and also carrier for goods. (2) Safety Bicycle, with special adjustment for chains.

798. METROPOLITAN MACHINISTS' CO., Limited (THE), 75 Bishopsgate Street Without, London, E.C.—(1) Bicycle. (2) Tricycle.

799. MOORE, THOMAS, 403 & 409 Kennington Park Corner, London, S.E.—The Orbi-cycle, with two speed gear, pedalling forward for speed, and by pedalling backwards the hill power is applied instantaneously, the wheels being geared down by this action.

800. MACONOCHE, J. R., 20 St. James's Square, Wolverhampton.—(1) Safety Steerage. (2) Adjustable Lamp Bracket for bicycles and tricycles.

801. ELLIS & CO., 47 Farringdon Road, London, E.C.—The Facile Safety Bicycle [Beale & Straw's Patent].

802. CRYPTO CYCLE CO., 73a Chiswell Street, London, E.C.—(1) Crypto-dynamic Power and Speed Gearing for the propulsion of tricycles, bicycles, &c. (2) Combined Balance and Crypto-gear. (3) The Speed Tricycles, with high normal speed, and a reserve power-gear instantly available when hills, head-winds, or bad roads are encountered.

803. THOMPSON, W. H., 68 & 71 Chiswell Street, London, E.C.—Rambly-cycle.

804. HOWE MACHINE CO., Limited (THE), Bridgeton, Glasgow.—(1) Bicycles and Tricycles with recent inventions: (a) For safer adjustment of bearings. (b) For improved springs in necks of bicycles.

805. BADEN-POWELL, W., 3 Paper Buildings, Temple, London, E.C.—The Cruiser Tricycle; a double front steerer. Steering is adjustable by compression as to sensitivity. Machine is disconnectable for transport or stowage.

806. HILLMAN, HERBERT, & COOPER, Premier Works, Coventry, 14 Holborn Viaduct, London, E.C. and 5 Lisle Street, Leicester Square

London, W.—(1) Safety Bicycles. (2) Ordinary Bicycles. (3) Single Tricycles. (4) Sociable Tricycles. (5) Show-case of Bicycle and Tricycle Parts.

807. COVENTRY MACHINISTS' CO., Limited (THE), 15 & 16 Holborn Viaduct, London, E.C.—(1) Patent Parallel Grip Vice. (2) Patents and Inventions in connection with bicycles and tricycles.

808. SINGER & CO., Coventry.—(1) Safety Bicycles, Tricycles. (2) Invalid Tricycles. (3) Balance Driving Gear. (4) Telescope Axles for tricycles. (5) Saddle Spring and Pedals. (6) Tricycle especially adapted for those who have lost a limb.

809. OTTO CO., Limited (THE), 118 Newgate Street, London, E.C.—(1) The Otto Bicycle, fitted with the new patent elastic spokes whereby vibration is remedied. (2) Lady's Otto Bicycle, with dress guards complete.

810. ROYAL MACHINE MANUFACTURING CO., Limited (THE), Herbert Road, Small Heath, Birmingham (Agents, W. J. PILE, 171 Fenchurch Street, London, E.C.)—Improvements in the Royal Mail Bicycles, Tricycles, Safety Bicycles. Convertible Tandem Tricycles, &c.

811. HART, SON, PEARD, & CO., Grosvenor Works, Grosvenor Street, West, Birmingham; and 168 Regent Street, London, W.—(1) Grosvenor Convertible Tricycle. (2) Grosvenor Spring Grips for avoidance of vibration.

812. NATIONAL CYCLE WORKS, Limited (THE), Coventry.—Improvements in velocipedes.

813. PAUSEY, HERBERT JAMES, Pioneer Bicycle & Tricycle Works, Clapham Park Road, London, S.W.—(1) Improved Parcel-carrying Tandem and Invalid Tricycles. (2) Safety Bicycle. (3) Double-steering Central-driving Tricycle. (4) Roadster, Racing, and Safety Bicycles, with patent wheels. (5) Pioneer Tradesman's Carrying Tricycle. (6) Pioneer Direct Steering Tricycle. (7) Pioneer Safety Bicycle.

814. SURREY MACHINISTS' CO., Limited (THE), 128 & 129 Great Suffolk Street, Borough, London, S.E.—(1) Patent Invincible Bicycles, Safety Bicycles and Tricycles. (2) Patent Double-section Hollow Rims for racing and roadster cycles of all kinds. (3) Patent Balance Gear, &c.

815. SAINT GEORGE'S ENGINEERING CO. (THE), Pope Street, Birmingham.—Improvements in Tricycles and Bicycles, including their new Tangent Wheel, and their Patent Detachable Handle Bar.

816. SETTLE, EDWARD RICHARD, Fleet Works, Coventry.—(1) Screw Driving Gear for tricycles and other velocipedes. (2) Non-slipping Twin-rubber Pedals. (3) Detachable Handle-bar and Telescope Rubber Spring for removing metallic vibration.

817. DUERRE, R., 15 King's Road, Chelsea, London, S.W.—Free and Easy Improved Tandem Tricycle and Bicycle Action.

818. HURRELL, W. E., 27 Ivy Lane, Hoxton, London, N.—(1) Enfield Tricycle, vertical action on any gradient without a swing frame. (2) Clyde Tricycle, open-fronted Humber type. (3) Equilibrium Combined Double-driving and Two Speed System.

819. MATHEWS, DANIEL, and TAYLOR, RICHARD, 67 Cornwall Road, Brixton Rise, London, S.W.—Improved Spring Motor for driving tricycles.

820. RIGG, THOMAS, 50 South Street, Rochdale.—Direct Driving by Feet on Front Crank Shaft and Front Steering Tricycles, with small hind wheel; central steering or bicycle action, with clutch gear and clutch brake; also fore and aft safety rods.

821. SPEED & WILLS, Waltham Cross, Herts.—Improvements in Velocipedes, propelled by direct action crank, and fitted with cork saddle.

823. TRIGWELL, J. R., 49 Boston Place, Dorset Square, London, N.W.—Patent Ball-bearing Bicycle and Tricycle Head.

824. WESTON, DAVID GEORGE, 38 Myddelton Street, Clerkenwell, London, E.C.—Central-action Double-driving Front-steering Tricycles. This action transmits equal power to both side wheels, and drives the outside wheel on turning a curve.

825. WARD, CHARLES JAMES B., 5 Mitre Road, Ridley Road, Rochester, Kent.—Patent Automatic Clutch. Model of tricycle fitted with clutch, and of a special and novel design, for obtaining the maximum amount of power in a lever and clutch driven machine.

827. STARLEY & SUTTON, West Orchard, Coventry.—Tricycles and Cycles, Single and Double, and Coventry chair.

828. ASTROP, WILLIAM, 11 Watcombe Villas, St. Anne's Road, Stamford Hill, London, N.—Improvements in apparatus for propelling tricycles and other wheeled vehicles and boats.

829. BUTLER, EDWARD, Sandford, Newbury, Berks.—New method for the mechanical propulsion of light vehicles, cycles, &c.

830. HOCKLEY, WILLIAM H., 40 Munty Street, Small Heath, Birmingham.—Improved Tricycle Driving Gear.

831. HUDSON, HENRY JOHN, 227 Blackfriars Road, London, S.E.—Improvements in velocipedes.

832. JACKSON, WILLIAM, 11 Caroline Street, Eaton Square, London, S.W.—Improvements in tricycles.

834. NUNAN, EDWARD, 166 Fleet Street, London, E.C.—Bicycle.

835. HICKLING & CO., Maidenhead, Berks.—Bicycles and Tricycles, viz.: (1) The Pilot Two-track F. S. (2) The Pilot Safety Bicycle. (3) The American Pilot Light Roadster.

836. STURGE, EDWIN, 27 Queen's Row, Walworth, London, S.E.—Improved Form of Tricycle.

838. LONDON CYCLISTS' EXCHANGE CO. (THE), 1 Devonshire Square, Liverpool Street, London, E.C.—Improvements in safety bicycles; no chains or cog-wheels. One machine adjustable to suit any rider. The machine is known as Taylor's [chainless] safety bicycle.

840. SALSBERY, JOHN E., 125 & 126 Long Acre, London, W.C.—(1) Patent Lamps for carriages, omnibuses, &c. (2) Oil Lamps for bicycles, tricycles, carriages, &c.

841. USHER, HENRY, 124 Vauxhall Bridge Road, London, S.W.—Improved Balance Gear for Tricycles.

842. WELCH, CHARLES K., High Road, Tottenham, Middlesex.—Improved Double-driving, Steering, and Speed Gear for velocipedes and other vehicles.

843. PHILLIPS, ROBERT EDWARD, 70 Chancery Lane, London, W.C.—(1) Improved Tandem Bicycle [Rucker's Patent]. (2) Improved Safety Bicycle [J. Tee's Patent]. (3) Improved Hub Lamp Bearing [Henson's Patent]. (4) Improved Grip Pedal [Phillips' Patent]. (5) Protector Tricycle Lock [Wiggett's Patent].

844. STORMONT, J. G., 112 Lionel Street, Birmingham.—Bicycle and Tricycle Bells, Table Call Bells, Gyroscope Spinning Tops, Planchettes, &c.

845. TANDY, H., 30 Victoria Road, Battersea, London, S.W.—Tricycles.

846. TROVERS, WILLIAM, York Terrace, Clapham, London, S.W.—Safety Bicycle.

849. HUMBER & CO., Beeston, Nottingham.—(1) Bicycle. (2) Safety Tricycle.

850. BROWNJOHN, MADAME, 35 Churton Street, South Belgravia, S.W.—Patent Tricycle showing ladies dress.

851. ATKINSON, J., Wilson Place, Belgravia, London, S.W.—Horse Shoes.

852. SEGGER, THOMAS, 125 Queen's Road, Bayswater, London, W.—Hydropathic Hood for horses.

853. SCANTLEBURY, WILLIAM, 15 Lea Bridge Road, Lower Clapton, London, E.—(1) Weighing Machine Centres for heavy weights. (2) Horse Clipper, worked by atmospheric pressure.

854. PRINGLE, HALL, 1 Stopford Road, Kennington, London, S.E.—Expanding Horse Shoe, formed wholly of iron. A protection against diseases from contracted hoofs and distortion of frog, the effect of rigid iron shoes. An adaptation of the thimble joint not a rivet.

855. ALLATT, CAPT., Royal Military College, Farnborough, Hants.—Patent Apparatus for hobbling horses, for use by mounted sportsmen, mounted infantry, and other troops. The horse's legs may be finally liberated by the rider in the saddle.

857. MARTIN, ALBERT, & CO., North Kent Works, Coleman Street, Woolwich, Kent.—Patent Horse-clipping Machines.

857. ROBERTSON, JOHN STEWART, 2 Clyde Street, Dumbarton, N.B.—Improvements in horse shoes.

858. GOLDFRAP, H., 68 St. George's Road, London, S.W.—Patent Nose Bag. By a simple arrangement the horse is enabled to lower and raise his head easily in the bag without obstruction.

859. MALLET, LIEUT.-COL. HAROLD, 18th Hussars, Royal Barracks, Dublin.—Drenching Bit, for the more humane and easier administration of medicine, especially to horses.

860. BURN & CO., 25 Wigmore Street, London, W.—Floyd's Patent Horse Shoe.

861. MOSS, RALPH, 56 Cannon Street, London.—Patent Cloths Reviver.

862. BRINKMAN, ARTHUR, 6 Swaton Road, Campbell Road, Bow, London, E.—Invicta Nailless Horse Shoe.

863. PRIEST & CO., 514 Oxford Street, London, W.—(1) Horseshoe Pads. (2) New Tail Cutters, &c.

864. BANTING, W. L., 7 Pond Place, Fulham Road, London, S.W.—(1) Safety

Horse Shoes, manufactured in steel. (2) Safe and easy method for fixing on carriage wheels.

865. **FERRIS, JOHN**, Regent House, Cambridge.—Improved Horse Shoe to prevent slipping.

866. **HP HORSE NAIL CO.**, Limited (THE), Acre Street, New Road, Wandsworth Road, London, S.W.—Horse Shoe Nails. Made in all forms and sizes from the finest Swedish charcoal iron. Painted, bright and ready for immediate use.

867. **MARTYN, ARTHUR**, 90 Chesham Road, Notting Hill, London, W.—Improvements in the method of fitting or fixing horse shoes, by which horses can be effectively and quickly shod without burning the hoof.

868. **NEWTON, WILSON, & CO.**, 102 Southampton Row, London, W.C.—Horse Grooming and Clipping Machines.

869. **BODY, WILLIAM**, Witterham, Ashford, Kent.—Horse Shoe Pads.

870. **BOX & BEADLE**, Erith, Kent.—Patent Durable Horse Shoe. Can be roughed and unroughed by the driver, applied to the hoof cold, and so does not injure the foot.

871. **SOUTH, W. A.**, 40 New Bond Street, London, W.—Rational Shoe.

872. **TOMLIN PATENT HORSE SHOE CO.**, Limited (THE), 16 Essex Street, Strand, London, W.C.—Patent Horse Shoes.

873. **WOOLDRIDGE, HENRY**, Wimpley Road, Lye, Stourbridge.—Horse Shoes, from nag to the largest cart-horse size. Fitted with patent interchangeable heel and chisel toe pieces and blunt and chisel heels. This invention enables every man in any weather to rough his own horse in a few minutes. (2) Horse Shoes fitted with frost [steel], by the use of which every man can shod his own horse in five minutes. (3) Means for instantly fastening frost coags. (4) Improved Steel Frost Nails, an efficient method of roughing horses. (5) Concave Shoe Bars and Splinters. (6) Various Classes of Iron and Steel Horse Shoes.

874. **LACEY, FREDERICK**, 4 Folley, Coopers' Arms Lane, London, S.W.—A Pole Head Slip for raising a horse when fallen.

875. **HARTLEY, REGINALD**, Haslemere, Surrey.—Patent Elastic Safety Shoe, to be attached to bearing reins, to relieve the pressure on the horse's mouth.

876. **GIBBONS, CHARLES K.**, 27 Coppington Street, Newcastle-on-Tyne.—Slip Link Safety Stirrup.

878. **BIRMINGHAM MACHINISTS' CO. (THE)**, 78 Parade, Birmingham.—Slip Link or Detaching Apparatus for chains, harness, &c.

879. **BUXTON, NATHANIEL**, 16 Fentiman's Road, South Lambeth, London, S.W.—Improved Safety Saddle Bar. It provides for the security of the rider when his horse is rearing or taking a fence, and cannot be jerked out. It cannot get entangled when the rider is thrown in any direction, but immediately releases him.

880. **WILSON, F. J.**, 73 Newman Street, Oxford Street, London, W.—Self-feeding Nose Bags.

881. **WINDER, RICHARD**, Farningham, Kent.—(1) New Patent Carriage Steel Nose Bands. (2) Patent Elastic Horse Shoe. (3) New Patent Spring Bicycle Saddle.

882. **WHEELER, JOHN**, Basingstoke, Hampshire.—Improved Side Saddle to prevent sore backs to horses, adapts itself to either hollow or straight backed horses, and to give power, comfort, and security to the rider.

883. **UNITE, JOHN**, 291 & 293 Edgware Road, London, W.—Patent Kennett Nose Bag.

884. **MITTON, PAUL**, 69 Oxford Street, London, W.—(1) Sheep Shears. (2) Bridles, Bits, and Reins [Querineau's Patent].

885. **DE MOUNCIE, BARON A. THORNTON**, 22 Sackville Street, Piccadilly, London, S.W.—Improved Method of biting horses for preventing them from pulling, rearing, or bolting.

887. **SLAZENGER & SONS**, 56 Cannon Street, London, E.C.; and Manchester.—Patent Cork Driving Rugs and Driving Coats.

888. **DI TERGOLINA, COUNT V.**, 36 Myddleton Square, London, E.C.—Improvements in bridles and bits. It is especially adapted for unmanageable horses, as the principle is on the lever system, which can be used at the discretion of the driver.

889. **OWEN & MILLER**, 125 Mount Street, Grosvenor Square, London, W.—(1) The Lady's Saddle, movable side. (2) Patent Safety Stirrup. (3) Steeplechase Saddle.

892. **EMANUEL, JOHN ISAAC**, 37 Clepham Road, Canonbury, London, N.—Improvements in connecting and disconnecting harnessed animals to vehicles.

893. **CAWDLE, THOMAS**, Belgrave Mews, Torquay.—Patent Safety Side Saddle.

894. CALLEY, SAMUEL, 11 Southwood Terrace, Southwood Lane, Highgate, Middlesex.—Improvements in bridles.

896. CHAMPION & WILTON, 457 & 459 Oxford Street, London, W.—(1) A Safety Side Saddle which prevents the rider being dragged, made upon an improved tree, giving the rider a straight seat. (2) An Improved Ventilated Cavalry Saddle to prevent hernia, and fitted with a safety stirrup hook. (3) An Electric Manger to prevent and cure crib biting.

897. COTTRELL, JAMES, JUN., 30 West Street, St. Phillips, Bristol.—Lock-up Safety Harness Shaft Tugs.

899. CURTIS, DEXTER (BARNETT, L., Manager), 59 Tenby Street North, Birmingham.—Patent Zinc Collar Pad for the prevention and cure of horses' sore necks.

901. DAVIS, A., & CO., 10 Strand, London, W.C.—(1) Universal Bit with interchangeable mouthpieces. (2) Safety Saddle Bar. (3) Harness Neck and Breast Collar combined. (4) Lady's Saddle with revolving leaping head. (5) Gent's Saddle Adjustable Tree. (6) Improved Cavalry Saddle. (7) Whip Splice.

902. WHITE & COLEMAN, 4 Bishopsgate Street Without, London, E.C.—(1) Spring Horse Collar. (2) Patent Harness Tugs, Whip & Rein Holders. (3) Safety Release Clip for saddle bar. (4) Automatic Spring for saddle girths. (5) Improved Stirrup Leathers. (6) Tandem Bar.

904. PEIRCE, WILLIAM ADAMS, Woolstone, Hampshire.—Improved Fastening for straps.

905. PIGGOTT BROTHERS, 59, 56 & 57 Bishopsgate Without, London, E.C.—(1) Summer and Winter Fawn, Kersey, Prince's Check and Jute Canvas Horse Clothing. (2) Hammock for raising sick horses.

906. BORN, HARRY, 173 Piccadilly, London.—Invention for improvements in saddle bars, so as to release the rider when thrown from horseback.

907. PEAT, HENRY, & CO., 173 Piccadilly, London, W.—The V. W. H., patent improvements in the panels and linings of saddles, harness pads, and collars.

908. KNIGHTLEY, GEORGE, 195, 197 Bethnal Green Road, London, E.—Spring Loop Fastener for harness, &c.

909. WALLEY, WILLIAM OWEN, 16 New Street, Altrincham, Cheshire, near Manchester.—(1) Horse Subjugator for instantly checking and controlling runaway or vicious horses. (2) Improved twin or sister

hooks for piecing or connecting all kinds of trace or hame chains, and also for attaching bridle reins to bit rings.

910. LENNAN & SON, 29 & 30 Dawson Street, Dublin.—(1) Safety Tug Harness, which enables the horse to be instantly released; combining elegant appearance and durability. (2) Safety Stirrups for ladies and gentlemen's riding. (3) Anti-Wind Suckers. (4) Habit Safeties. (5) Improved Side Saddle, only 15 lbs. weight complete. (6) Hunting Saddles of various weights and shapes. (7) Flat-race Saddle, only 2 lbs. (8) Steeplechase Saddles. (9) White Doe Leather. (10) Polo Saddle. (11) Bridles of various kinds, &c.

911. CRADDOCK, GEORGE, 378 Gray's Inn Road, King's Cross, London, N.—Improvements in harness and saddlery.

912. URCH & CO., 84 Long Acre, London, W.O.—Patent Double Spring Bar for releasing the stirrup leather when thrown, for ladies or gentlemen's saddles.

913. NICHOLLS, F. V., & CO., 2 Jermyn Street, London, S.W.—(1) Narrow Grip Hunting and Park Saddles for gentlemen. (2) Level Seat Side Saddles, with safety habit bands. (3) New Patent Safety Saddle Bars for ladies and gentlemen. (4) New Patent Safety Stirrups for ladies and gentlemen. (5) Patent Air Panel Pads for saddles. (6) A Pocket Dumb Jockey for mousing and suppling horses. (7) A Military Ventilated Seat, Campaigning Saddle.

LONDON BICYCLE & TRICYCLE CO. (THE), 30 Victoria Road, Battersea, London, S.W.—Improvements in velocipedes, and in speed and power gearing.

BEZER, HENRY, 12 Teddington Park Road, Teddington. (See Group XII.)

BRABY, JAMES, Maybanks, Rudgwick, Sussex. (See Group IV.)

COPPARD, J., & CO., 35 Holloway Road, Islington, London, N. (See Group XVII.)

COTTAM & CO., 2 Winsley Street, Oxford Street, London, W. (See Group III.)

GROOMBRIDGE, CHARLES, Clifcote, Oliver Road, Leyton, Essex. (See Group III.)

GROVER, H. CHARLES, Beechwood, Claremont Road, Highgate, London, N. (See Group V.)

JOY, DAVID, 8 Victoria Chambers, Westminster, London, S.W. (See Group IV.)

KAYE, JOSEPH, & SONS, Patent Lock Works, South Accommodation Road, Leeds; and 93 High Holborn, London, W.C. (*See Group XXIV.*)

MASSEY, B. & S., Openshaw, Manchester. (*See Group II.*)

PATENT (METAL) DIE CO., Limited, 29 Addington Street, York Road, London, S.E. (*See Group XI.*)

PATENT NUT & BOLT CO., Limited (THE), London Works, near Birmingham. (*See Group III.*)

PIKE, WILLIAM HENRY, Albion Hotel, Lanark, N.B. (*See Group XXIV.*)

RANDALL, L. D., & CO., Standard Works, Wapping, London, E. (*See Group XX.*)

RANSOMES, SIMS, & JEFFERIES, Limited, Orwell Works, Ipswich. (*See Group I.*)

ROE, J. T., 3 Earls Villas, Balham Park Road, London, S.W. (*See Group V.*)

SMITH, M. H., Royal Insurance Buildings, Halifax. (*See Outside, South Promenade.*)

TAYLOR, ALFRED, Lynton Villa, Pawsen's Road, West Croydon. (*See Group XIV.*)

UNITE, J., 291 & 293 Edgware Road, London, W. (*See Group I.*)

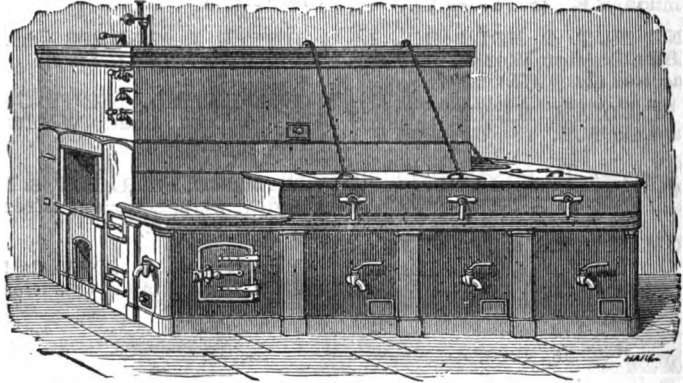
WETHERED, LIEUT.-COL. E. R., 100 Herbert Road, Woolwich, Kent. (*See Group XXIV.*)

WINTER, MERIGOT, & FROST, 56 Conduit Street, Regent Street, London, W. (*See Group V.*)

YOUNG, C. S., 90 Wells Street, Lozells, Birmingham. (*See Group VII.*)

BENHAM'S PATENT COOKING APPARATUS,

For Boiling, Roasting, Stewing, Broiling, Steaming, Baking Bread and Pastry, &c.,
and Supplying Hot Water for Baths and Laundries,
FOR LARGE NUMBERS, WITH A SINGLE FIRE.



THE SPECIAL ADVANTAGES OF THIS APPARATUS ARE

Remarkable Economy of Fuel; Simplicity of Management; Perfect Control;
and Great External Coolness.

What alone enables us to draw a just moral from the Tale of Life?



"Were I asked what best dignifies the present and consecrates the past; What alone enables us to draw a just moral from the Tale of Life; What sheds the PUREST LIGHT UPON OUR REASON; What gives the firmest strength to our Religion; What is best fitted to *soften the heart* of man and elevate his soul, I would answer with Lassues, it is

EXPERIENCE."

LORD LYTON.

"It is estimated by a *very low calculation* that at least 220,000,000 are lost every year in consequence of those diseases which the science of Hygiene teaches us *how to avoid*. Typhoid fever alone kills 20,000 every year in this country; as only about 15 per cent. of those attacked die, there must be at least 134,000 cases every year, and it is probable that the number is *CONSIDERABLY GREATER!*"—*Dr. Newsholme.*

What mind can grasp the loss to mankind, and the misery entailed that these figures reveal? What dashes to the earth so many hopes, breaks so many sweet alliances, blasts so many auspicious enterprises, as untimely death? To say nothing of the immense increase of rates and taxes arising from the loss of the breadwinner of families.

WE ARE AT PRESENT AT THE MERCY OF THE IGNORANT AND CARELESS.

In order to prevent a disease, it is necessary to remove its causes; by that means you hinder the germ or poison from gaining admission. At the same time you must sustain the vital powers by adding to the blood what is continually being lost from various causes, and by that means you prevent the poison being retained in the body. The effect of

ENO'S FRUIT SALT

Is to take away all morbid poison and to supply that which promotes a healthy secretion.

HUNDREDS OF THOUSANDS OF LIVES MAY BE SAVED ANNUALLY, AND MILLIONS FREED FROM INCALCULABLE SUFFERING.—Millions have died from Preventible Diseases in this country. It is the duty of every one to avert this. With each bottle of ENO'S FRUIT SALT is wrapped a large Illustrated Sheet, showing the best means of stamping out infectious Diseases, Fevers, Blood Poisons, &c. If this invaluable information were universally carried out, many forms of Disease now producing much havoc would cease to exist, as PLAGUE, LEPROSY, &c., have done, when the true cause has become known.

CAUTION.—Examine each Bottle, and see that the Capsule is marked "ENO'S FRUIT SALT." Without it, you have been imposed on by a worthless imitation. Sold by all Chemists.

Prepared only at Eno's Fruit Salt Works, Hatcham, London, S.E., by J. C. Eno's Patent.

NAVAL ARCHITECTURE.

BY SIR EDWARD J. REED, K.C.B., M.P., F.G.S.

THE progress which has been made in Naval Architecture (in which, for the present purpose, marine engineering is included) during the twenty-five years which are covered by the inventions displayed in this Exhibition, is greater and more remarkable than the aggregate progress made in all the preceding ages of the world. This is said in full view of the fact that the introduction of steam navigation had been effected long before 1860, and that the *Great Eastern* had been built prior to that time. If we were dealing here with the phenomena of naval architecture, and not with its steady progress, the previous appearance of the *Great Eastern* upon the ocean would, it is true, affect the accuracy of the opinion above expressed; but regarding her, as she at the time was, as a huge phenomenon, magnificently illustrating the constructive genius of England, but taking no place in the gradual evolution of the ship of to-day from the ship of the ancients, it may truly be said that the last twenty-five years have improved the character both of the commercial and of the war ship more than it had been previously improved by the accumulated labours of all the foregoing ages.

After the Great Exhibition of 1851, at the suggestion of the late Prince Consort—who, “being dead, yet speaketh” in many ways, and as but few speak so long after death—a course of lectures was given upon the results of that Exhibition, and in his lecture upon the Naval Department, the late Admiral Washington said, by way of illustrating the progress that had then been attained, “now, steamships of 2000 tons burden and 500 horse-power are navigating the Pacific and Indian Oceans; and they weekly cross the Atlantic at the average rate of ten miles an hour.” There are now in 1885 more than fifty merchant and passenger steam-ships afloat of about 5000 tons (gross) and upwards, of which ten exceed 6000 tons, and two exceed 8000. Some of the largest of these have steamed at twenty knots (equal 23 miles) an hour, and have made the passage between New York and Queenstown in less than seven days. In respect of war ships, Admiral Washington spoke as follows:—

“Amidst the sparkling of the crystal fountain, backed by a forest of tropical plants, and with the rich hangings of Persia and India on either hand, there sat the *Queen* of the Ocean, simple, severe, yet beautiful in form, a type of the progress of art as applied to ship-building during the last eighteen centuries. The transition from the inconvenient and unsightly forms of antiquity to the graceful outline and imposing contour of a first-class ship of war, is no less remarkable, as an indication of progress in this science, than instructive as practical evidence of the consistency of beauty of form with those qualities of speed, strength, storage and stability which are essential in such structures.”

Of all that was characteristic in the great line-of-battle ship *Queen*, thus justly eulogised in 1852, not a vestige is to be traced in the iron-clad line-of-battle ship of to-day, the famous model itself having now to be sought in the Naval College Museum at Greenwich, where it is preserved as an antiquity, not less out of all relation to the armoured *Benbow*, under construction on the opposite side of the Thames at Blackwall, than are the models of Henry's *Grace de Dieu*, or Charles's *Sovereign of the Seas*. As to marine engines, the most powerful mentioned by Admiral Washington in 1852 were of 1800 indicated horse-power; some of the recently-built Transatlantic liners are driven by engines developing 12,000 horse-power.

One of the greatest lessons deduced from the Naval Architecture branch of the Exhibition of 1851 (was to use the language of the authority previously quoted) that there existed a “want of union between science and practice, and of more intimate communication between scientific and practical men.” It is gratifying to be able to relate that in 1860, and therefore at the very beginning of the twenty-five year period which this Exhibition covers, the “Institution of Naval Architects and Marine Engineers” was founded, expressly to bring about the “union” and the “communication” referred to, and has ever since pursued with marked success the objects in view. The *Transactions* of this body constitute in large degree a record of the progress which the present Exhibition illustrates.

The materials of which ships and their engines are constructed have of late years undergone

immense improvement by the introduction of many antecedent improvements in the manufacture of steel. And although this remark mainly applies to the production of plates, beams, angle irons, &c., of ductile steel, such as are now becoming very generally employed in shipbuilding, it has numerous other applications. Cast-steel stern frames, rudders, stems, and other parts of the hulls of ships are coming rapidly into use, while in marine boilers and machinery, steel castings and forgings are continually displacing those of iron, and with great advantage. The inner cylinder or liner of the engines of H.M. ships are now usually formed of Whitworth compressed steel, forged hydraulically to the size for boring; and the same may be said of the screw-hatting. Either forged or cast steel propellers are generally displacing the brass screws of the Royal Navy and the cast-iron screws of the Mercantile Marine. The aggregate reduction of weight obtained by this general introduction of steel throughout the hulls and machinery of ships is very great, and its economical results are in a high degree valuable; the carrying power of the vessel, the steam power developed, and the efficiency with which the power is applied being all considerably increased.

The structural arrangements of the hulls of ships have undergone very great improvement during the last twenty-five years. At the commencement of that period there were very few ships indeed (of which the most notable was the *Great Eastern*) built with an inner bottom. In H.M. ironclad ship *Warrior* (1860) and her contemporaries a system of construction was adopted which provided a double bottom throughout the engine and boiler space, but involved great weight. In the *Bellerophon* (1864) a much simpler and lighter system, known as the "Bracket-Frame" system, was introduced and carried out to a greater extent. Since that time some form of double bottom arrangement has become very general in both the Royal and the Mercantile Navy, the space between the bottoms being often utilised in merchant ships for the carriage of water-ballast for the regulation of their "draught" and of their "stability." Iron or steel upper decks, and in many ships main decks of like material, have also become general, thus greatly improving the strength of the ship's structure regarded as that of a floating girder. The internal division of ships by solid water-tight bulkheads has, under the auspices of the Admiralty, undergone great and invaluable extension, both in H.M. ships and in those of the Mercantile Marine. The necessity for not only multiplying the number of such bulkheads, but also carrying them up to a sufficient height above the load-line to prevent the water from a compartment which has been breached and filled flowing, as the ship sinks lower, over the tops of the enclosing bulkheads into adjacent compartments, has come to be widely realised and acted upon. The Admiralty now have more than 300 steamships of the Merchant Navy upon their list of vessels which have sufficient water-tight sub-divisions to be deemed safe with one compartment breached and filled. Many of the number are much more largely and effectually subdivided than this fact alone would indicate. Another very great improvement which has been effected in the vessels of the Mercantile Marine, and more especially in those built chiefly for the carriage of cargo, is that of the enclosure of the engine and boiler hatches within solid iron decks, carried up to a height of seven or eight feet above the upper deck, and surmounted with strong coamings and covers for ventilation. Indeed there has been a very general increase of closed deck constructions, which have added greatly both to the safety and to the comfort of the officers and men.

Great progress has been made during the past twenty-five years in the generation and employment of steam for the propulsion of ships. This has been primarily exhibited in the production of steam at what would have been regarded at the commencement of that period as immense pressures, and in the utilisation of this high-pressure steam in compound engines constructed as to admit of its undergoing successive expansions in separate cylinders. Steam when of a pressure of not more than about 100 lbs. can be advantageously employed in compound engines which provide for a first expansion in one cylinder, and a second expansion in another, or, by the preference of most engineers, in two other cylinders; when its pressure exceeds, or much exceeds, 100 lbs., provision is now made of an intermediate cylinder, for a medium expansion and what is known as "triple expansion" is thus arranged for. Engines of this type are now becoming general, their great economy having been proved to the satisfaction of several ship owners of large experience. During the twenty-five years under review, the consumption of fuel per unit of power has been reduced upon the average of marine engines by more than one-half, in some cases by very much more than one-half. In torpedo boats first, and more recently in much

larger vessels of war, the system of increasing the generation of steam by means of artificial draught, has likewise undergone great extension, the plan usually adopted being that of closing the stokehold, and forcing air into it with revolving fans.

The introduction of very fast and extremely light steel steamboats of small dimensions, and their extended use for pleasure as well as for war purposes, is of recent date, being due to the initiative of Mr. Thornycroft. It has had the effect of greatly stimulating the employment of very thin steel in the construction of the hulls of vessels of much larger dimensions than the originator of the system himself probably contemplated.

The application of steam-power, and likewise of hydraulic-power, to the interior services of both merchant ships and war ships, has undergone remarkable development. When it is stated that there were on one occasion no less than sixty-eight men applied to the wheels and steering tackles of a large iron-clad frigate, in order to get her helm over with all the rapidity possible, and to the greatest available angle, the value of steam and of hydraulic steering apparatus, with which a single man can quickly put the helms of the largest ships "hard over," will be appreciated. In war ships auxiliary steam engines are applied for performing all the more arduous duties of the ship—revolving the turrets, weighing the anchors, pumping the holds, raising the ashes, and many other such purposes—while hydraulic apparatus is used for raising the ammunition from the magazines, loading the guns, and otherwise performing the principal fighting operations. In merchant steamers likewise, the steering of the ship, the working of the capstans, the shipment and landing of cargo, and other operations are all coming to be more or less generally carried on by means of steam or hydraulic machinery. Portable and other steam and hydraulic appliances are also now employed by shipbuilders and marine boiler makers for riveting the work together.

The marked progress in naval architecture and marine engineering which has been sketched above has not been unattended by very great advances in the sciences which guide and regulate the work of shipbuilders and engine-makers. Nor is it undeserving of special notice that the recent developments of naval science have been characterised by the intimate connection of theory and experiment. The late Canon Moseley, in 1850, set the excellent example of thus associating theory and practice, verifying and checking his mathematical investigation of Dynamical Stability by experiments on the oscillation of floating bodies carried out in Portsmouth Dockyard. Pursuing a like course, in the development of the same subject, and of the doctrines of fluid resistance, the late Mr. William Froude constructed at Torquay a long experimental tank, and established a systematic course of combined theoretical and practical inquiry, which led to a considerable extension of our scientific knowledge respecting the resistances exerted upon ships, both when advancing and when oscillating transversely, and likewise upon the action of screw propellers, in different positions, &c. His inquiries were for many years assisted by funds voted by Parliament at the desire of the Admiralty. Subsequently experimental tanks or canals have been constructed and employed for similar purposes at the works of Messrs. Denny Brothers, of Dumbarton, and of Messrs. J. and G. Thompson, also of the Clyde.

The doctrines of stability have become of vital importance to those engaged in constructing novel types of war ships, and equally to those engaged in the transport of goods by sea, more especially upon long voyages. The multiplication of losses of ships from deficient stability under certain probable conditions, or from ignorance of those conditions, aroused the anxious attention of shipowners and shipbuilders everywhere to the question of the stability of ships under varying stowage, and with the result that the doctrines of ship-stability have undergone very remarkable extension of late, to which extension the naval architects of France have contributed in a remarkable and praiseworthy manner, which deserves cordial recognition at this International exchange of ideas and achievements.

The scientific principles upon which the strength of the various parts of a ship's structure should be regulated have undergone great extension, and are now becoming more generally understood. These principles cannot be satisfactorily or sufficiently inferred from those which regulate the construction of fixed bridges or girders, owing to the waves of the sea subjecting a ship to great changes of position, and to strains and impacts which are experienced by ships alone. In this instance again is seen the necessity of verifying and correcting abstract calculations by the close and continual observation of actual ships during rough voyages or other trying experiences.

This outline of modern progress in naval construction must necessarily, from its brevity, be incomplete; but mention must be made, before concluding it, of the simplification which the calculations of the naval designer have recently undergone by the introduction of mechanical systems of computation. The most conspicuous and valuable of these is the *Amster-Laff Mechanical Integrator*, whereby the area, the statical moment, and the moment of inertia of an enclosed curvilinear area can be ascertained by simply passing the point of the instrument along its boundaries, and reading off the results.

GROUP VII.—NAVAL ARCHITECTURE.

SOUTH OF QUEEN'S GATE ANNEXE.

[For Floating Docks and Dredging Apparatus, see Group III.; for Engines and Marine Engines, see Group IV.; for Nautical Instruments, see Group XXVII.]

921. ADMIRALTY LORDS COMMISSIONERS, Whitehall, London, S.W.—Models of the following ships: 'Devastation,' built at Sunderland, 1875; 'Monarch,' built at Chatham, 1868; 'Rupert,' built at Chatham, 1872; 'Glatton,' built at Chatham, 1871; 'Opal,' built at Sunderland, 1875; 'Staunch,' built by Sir W. Armstrong & Co., 1867; 'Inflexible,' built at Portsmouth, 1874.

922. BARRY REES & CO., Royal Naval College, Greenwich, London, S.E.—Disengaging Hooks for ships' boats. Also Boat's Davits.

923. BADEN-POWELL, W., 3 Paper Buildings, Temple, London, E.C.—The 'Nautilus' Sailing Canoe, fitted with the nautilus rig centre plate, and foot steering gear.

924. MAYNARD, F. G., Devonshire Boat House, Grove Park, Chiswick, Middlesex.—Center Board Sailing and Rowing Boat.

925. BEAMISH, G. H. T., Spy Hill House, Queenstown, Ireland.—Improvements in ships and boats; whereby the rolling and pitching of the vessel are utilized for a source of propulsion.

926. BARRETT, G. J. T., 253 Essex Road, Islington, London, N.—Collapsible Girder Boat.

927. HALL, T. A. F., Manor House, Millbrook, Southampton.—Improvements in rafts, applicable also for use as pontoons.

928. BARROW SHIPBUILDING CO., Limited (THE), Barrow-in-Furness, Lancashire.—Half Models of ships.

929. WATKINS & CO., Orchard Yard, Blackwall, London, E.—(1) Nile Boat, similar to those now being used in Lord Wolsey's expedition. (2) Models of steam and sailing yachts.

930. LAIRD BROTHERS, Birkenhead Iron Works, Birkenhead.—Models illus-

trating the progress in paddle-wheel channel mail steamers since 1840, and screw mail steamers since 1852. Also models of several early iron steamers.

931. ARMSTRONG, SIR WILLIAM G., MITCHELL, & CO. (Limited), Elswick, Newcastle-on-Tyne.—(1) Full Model of Chilean Cruiser *Esmeralda*, built in 1884, 3000 tons displacement, 18 knots speed. *Armament*.—Two 26-ton B. L. guns, six 6-ton B. L. guns, two 6-pr. rapid fire guns, Elswick pattern; six machine guns. (2) Set of three Photographs of Chilean Cruiser *Esmeralda*, being respectively broadside view of vessel in harbour, bow view in dock, and the third an instantaneous photograph taken at sea while the cruiser was steaming at the rate of over 18 knots. (3) Half Model of Second Class Torpedo Cruiser, now building at the Elswick shipyard, 2100 tons displacement, 18½ to 19 knots speed. *Armament*.—Six 6 ton B. L. guns, nine 6 pr. rapid fire guns, Elswick pattern; six rapid fire Gatlings. (4) Full Model of Austrian Torpedo Cruisers now building at the Elswick shipyard. (5) Set of Half Models of Gunboats, showing the gradual development of the *Staunch* type, commencing with the *Staunch* herself, built in 1867, 160 tons displacement, 7½ knots speed. *Armament*.—One 12½ ton 9-inch M. L. gun. The set embraces the following:—*Duke* gunboats *Ever* and *Hydra*, built in 1867, 170 tons displacement, 8 knots speed. *Armament*.—12½ ton 9-inch M. L. gun. In one of these [the *Hydra*] the gun is on a disappearing carriage. H.M. gunboats *Mastiff* and *Bloodhound*, built in 1871, 290 tons displacement, 8½ knots speed. *Armament*.—One 10-inch 18 ton M. L. gun. Chinese gunboats *Alpha* and *Beta*, built in 1876, 320 tons displacement, 9 knots speed. *Armament*.—One 11-inch 26½ ton M. L. gun, worked and loaded by hydraulic power. Chinese gunboats *Gamma* and *Delta*, built in 1877, 400 tons displacement, 9 knots speed. *Armament*.—One 12-inch 38 ton M. L. gun, worked and loaded by hydraulic power. Chinese gunboats *Epsilon*, *Zeta*, *Eta* and *Theta*, built in 1880, 440 tons displacement, 10 knots speed. *Armament*.—One 11-inch 35 ton M. L. gun, worked and loaded by hydraulic power, two 12-ton B. L. guns, two Gatlings. Chinese gunboats *Iota*, *Kappa*, and *Lambda*, built in 1884, 440 tons displacement, 10 knots speed. *Armament*.—

pent.—One 11-inch 35-ton M. L. gun, worked and loaded by hydraulic power, two 12 pr. B. L. guns, two Gatlings. (6) Full Model of H.M. Gunboat *Staunch*, 160 tons displacement, 7½ knots speed. *Armament*.—One 9-inch 12½ ton B. L. gun. (7) Full Model of Japanese Cruiser *Tsukushi-Kan*, built in 1881, and Chinese cruisers *Chao-Yung* and *Yang-Wei*, built in 1881, 1300 tons displacement, 16 knots speed. *Armament*.—Two 10-inch 25 ton B. L. guns, worked and loaded by hydraulic power, four 12 c/m. guns, two 9-pr. guns, four sailing guns, two Nordenfolt guns. (8) Half Model of Russian Imperial Yacht *Heryklik*, built in 1866, 1100 tons displacement, 14 knots speed. (9) Half Model of H.M. Troopship *Myne*, built in 1878, 4100 tons displacement, 14 knots speed. (10) Full Model of H.M. Colonial Cruiser *Protector* [Government of South Australia], built in 1884, 900 tons displacement, 14 knots speed. *Armament*.—One 11-inch B. L. gun forward, five 6-inch B. L. guns placed aft, two on each broadside, five sailing guns. (11) Imperial Russian Armour-clad *Prince Pojarski*, built in 1866, 3500 tons displacement, 13 knots speed. (12) Second-class Armour-clad, 6000 tons displacement, 15 knots speed. *Armament*.—Four 43-ton B. L. guns in two barbettes, four 6-inch B. L. guns, two 6-pr. rapid-fire guns. (13) Half-Model of Merchant Steamers, *St. Osyth* and *Hankow*, built in 1874, 7200 tons displacement, 13 knots speed. The *St. Osyth* was one of the first steam-powered steamers that made the passage from England to Australia; her sister ship the *Hankow* has been frequently employed by the Government as a troopship. (14) Half Model of the Imperial Japanese Protected Cruisers, and *Naniwa-Kan* and *Takasago-Kan*, built in 1885, 3600 tons displacement, 18 knots speed. (15) Half Model of Steamship *Jan Breydel*, built in 1880, 3000 tons displacement, 11 knots speed. Type of cargo vessel suitable for Atlantic or Eastern service. (16) Half Model of Twin Screw Cable Steamer *Faraday*, built in 1874, 9000 tons displacement, 11 knots speed. This vessel has the peculiarity that her bow and stern are of exactly the same form, including a rudder at each end, so that if it is desired while laying the cable to haul it back on board, this can be done without turning the ship, which, under many circumstances, might cause a breakage of the cable. It may be mentioned that the cable steamer *Hooper* [now named the *Silverdale*], of about the same tonnage as the *Faraday*, was launched by the same builders in an extraordinary short space of 100 working days from the time her keel was laid, and was fully finished in seven months from date of laying. (17) Full Model of Passenger Paddle Steamer *Morpeth*, 1000 tons displacement, 12 knots speed, for Australian coasting service. (18) Set of Half Models of vessels built for service in the Caspian, Azoff, and Black Seas. The whole of the vessels are fitted with special apparatus for burning petroleum as fuel, and

several of them have been constructed specially for the carriage of petroleum in bulk with powerful pumping appliances, so that the entire cargo can be loaded or discharged in a few hours. (19) Full Model of Paddle Passenger Steamers, *Rosalind*, *Celia* and *Orlando*, now building for the River Thames Steamboat Company, Limited, to be employed in an improved passenger service between Battersea and Greenwich. The cabins will be light and airy, and the vessels will be well sub-divided by watertight bulkheads, giving great safety in the event of the vessel being pierced by collision or otherwise. (20) Half Model of Steel Paddle Steamer *Oput*. Type of tug and passenger steamer for shallow rivers, built 1870, 90 tons displacement, 21 in. draft, 60 H.P. (21) Half Model of Nile Steamer, *Safia*, built 1862, 150 tons displacement, 10 knots speed. The *Safia* was the last steamer abandoned by Sir Charles Wilson at Gubat, after his unsuccessful mission to Khartoum. (22) Half Model of Steel Paddle Steamer *Goretz*, built in 1882, 325 tons displacement, 3 in. draft, 160 H.P. nominal. Type of tug and passenger steamer employed in the river Volga. (23, 24) Photograph and Full Model of a Floating Dock, built 1877, for the Dutch Government service in connection with harbour works in Java, and intended for docking dredgers and hopper barges, a full model of one of which is shown in the dock. It may be mentioned that the dock consists entirely of horizontal and vertical cylinders which were completely riveted and caulked in this country, the dock being then launched and tried previous to its shipment to Java, where it was re-erected by merely bolting the pieces together, no riveting whatever being required, which is a desideratum where skilled labour is not available. The photograph shows the dock in various conditions during its trial in this country. (25) Half Model of Iron Screw Yacht *Nora*, built 1880, 530 tons displacement, 11 knots speed. (26) Half Model of Twin Screw Cable Steamer *Pouwer-Quertier*, built 1879, 3200 tons displacement, 10 knots speed. Employed in the repair of Atlantic cables. This vessel, like the "*Faraday*," has a rudder at each end, although her stern above water is of the ordinary form. (27) Full Model of Japanese Screw Steamers *Yamashiro Maru* and *Omi Maru*, 5000 tons displacement, 13 knots speed. Intended principally for carrying mails and passengers, but also adapted for service as armed transports, for which purpose they are fitted with four 17 c/m B. L. guns.

932. WHITE STAR LINE (ISMAY, IMRIE & CO.), 10 Water Street, Liverpool.—Model of an Atlantic passenger steamer.

933. THAMES IRON WORKS AND SHIPBUILDING CO., Limited (THE), Orchard Yard, Blackwall, London, E.—Models of the 'Warrior' and 'Benbow,' being ironclads of the earliest and latest types built

by this firm for the British Navy, and sundry models of war ships, &c., built for foreign powers.

934. TURK, R. J., Kingston-on-Thames.—(1) Canoe for sailing and paddling, built ribbon-carvel, fitted with centre-board, and self-reefing sails. (2) Canoe, to carry one, two, or three persons, to be propelled by paddles or oarlocks. (3) Rowing Skiff. (4) Self-reefing sails of various kinds.

935. DICKIE, JAMES, 1 East Parade, Leeds.—The New Aqua-Aerial or Wave Ship. A new form of steamer designed to attain railway express speed at sea, combined with safety and steadiness. Suitable for express mail and passenger services, for war ships, torpedo boats, yachts, and all cases in which great speed and quick manœuvring qualities are desirable.

936. POTHONIER & CO., 21 Great St. Helen's, London, E.C.—Model of a screw steamer 1000 tons deadweight on 18 ft., and specially designed for light draft trades.

937. ROYAL NATIONAL LIFE-BOAT INSTITUTION, 14 John Street, Adelphi, London, W.C.—Improved Self-righting Life-boats.

938. HAMAND, A. S., Palace Chambers, Bridge Street, Westminster, London, S.W.—Improvements in ships, piers, quays, breakwaters, and bridges.

939. WILLIAMS, THOS. H., A.M.I.C.E., F.S.A., 11 Queen Victoria Street, London, E.C.—Williams's Sea-going Torpedo Boat. Is armed with two Nordenfelt rapid-fire 6-pounder shell guns, mounted fore and aft, in shell-proof turrets and shields; 4 Hotchkiss machine guns also mounted in shell-proof barbets and shields; and 2 Bow tubes for discharging torpedoes. The stoke hole is separated from boiler by double bulkhead and safety apparatus. Engines and boiler are of an improved type. Total displacement 70 tons. It will steam 1600 miles without coaling at 12 miles an hour. The engines develop 850 indicated horse power. Speed 23½ knots per hour [27 statute miles].

940. SAMUDA BROTHERS, Poplar, London, E.—(1) Model of the 'Riachuelo' fast and powerful armour-clad turret ship, built for the Brazilian Government, 16½ knots speed. (2) Model of the 'Mary Beatrice' steel paddle-wheel passenger steamer for the South-Eastern Railway Company for service between Folkestone and Boulogne. The fastest vessel of her class; speed 19 knots per hour.

941. CAPPER, ROBERT, Swansea.—Model of Dredger, as used by Swansea Harbour Trust.

943. HEATHORN, CAPTAIN T. B., R.A., 10 Wilton Place, London, S.W.—(1) Water Brakes. (2) Rudder Propellers, and combinations of both.

944. GREEN, R. & H., Blackwall Yard, London, E.—Model of light vessel.

945. YARROW & CO., Isle of Dogs, Poplar, London, E.—(1) Model of steam wheel steamers 'Lotus' and 'Waterlily,' built for the Nile expedition. (2) Model of four screw going torpedo-boats for the Brazilian Government.

946. TAGG, T. G., & SONS, Hamerton and East Molesey.—Patent Diagonal constructed Punt Sailing Boat, shewing patent caulking seams.

947. OSWALD, MORDAUNT, & CO., Southampton.—Models of steamers and special model of new design of twin-tailed screw vessels and other improvements.

948. SALTER, JOHN, Universal Boat House, Oxford.—A Selection of Boats showing the inventions and improvements of the last ten years. (1) Mahogany Punt Skiff, fitted in most approved style. (2) Skiff headed Rowing Punt of new design. (3) Angled Canadian Canoe.

949. COPEMAN & PINHEY, 4 Victoria Street, Westminster, London, S.W.—Deck Seats for saving life at sea, and military tank raft.

950. SKELTON, GEORGE, Longdon House, Millwall, London, E.—Model of lifeboats built of galvanised steel. The boats are not affected by exposure in hot climates.

951. RIGG, JAMES, 11 Queen Victoria Street, London, E.C.—Patent Automatic Drop to avoid the fall and consequent breakage of coal and other descriptions of cargo in passing from ordinary shoots into ship's hold.

952. SCOTT, MICHAEL, F.R.S., in the care of ALEX. GRAHAM, 80 George Street, Westminster, London, S.W.—Improved Ships of War, with ends and turrets abreast, with ends protected sloping under water armour deck, and with cellular system, &c.

953. FISHWICK, CAPTAIN J., Nelson Place, Barnstaple.—Apparatus for scraping or cleaning the bottoms of ships, whilst afloat, either on a voyage or in dock.

954. HILL, E. J., 6 Westminster Chambers, London, S.W.—Boat-lower Gear.

955. LEHMANN, A. J., 12 Delamater Street, Kirkdale, Liverpool.—Patent system of loading bulk cargoes.

956. HAMILTON, ALEX., 108 Bow Hill, Greenwich.—(1) Inventions for saving life at sea. (2) Improved Life Boats and Tugway Rail Cleaner.

957. HOLMES, J. R., 12 Waterloo Street, Glasgow.—(1) Improved Landing

quishable Signal Lights for marine and land purposes. (3) Holmes's Ozone Fluid for removing mildew from sails without injury, and producing snow-white decks and cabin floors, at the same time deodorising and disinfecting.

92. **MACKIE, E. J.**, Turk's Head Yard, Turnmill Street, London.—Construction of Iron Ships whereby strength and safety are secured, including a novel mode of propulsion.

93. **HOLMES'S MARINE LIFE PROTECTION ASSOCIATION**, Limited, 8 Great Winchester Street, London, E.C.; and Warrington, Lancashire.—New Patent Inextinguishable Life-buoy Lights, Danger Signals, Collision Lights, Torpedo Indicating Lights, &c.; Patent Continuous Boat and Mechanical Reed Fog Horns, &c.

94. **INDESTRUCTIBLE PAINT** CO., Limited, 27 Cannon Street, E.C., showing a Preservative Paint and Composition for ships and other purposes.

95. **MUTER, HARTMANN, & CO.**, 11 Billiter Street, London, E.C.—Original Shipmen's Composition for ships' bottoms.

96. **SIMPSON & DENISON**, Dartmouth, South Devon.—Yachts, Steam Launch, and Four-oared Gig combined [twenty-two feet long], fitted complete with Kingston's Patent Compound Surface Condensing Engine and Natural Draught Boiler; also Simpson & Denison's Patent Feed and Air Pumps, and Onboard Surface Condenser. Showing a novel arrangement of Compound Machinery, adapted for small boats.

97. **GARDNER, A., & SON**, 36 Malmaison Street, Glasgow.—Process for rendering ordinary mattresses, &c., into life-saving apparatus, with new spring mattresses; timber prepared to avoid shrinking and swelling for decks, &c.

98. **SHOEBOOTHAM, J. H.**, Sheepen Street, Birmingham.—(1) Shoebootham's Chain Link. (2) Patent Iron Sail Ropes. (3) Shoebootham's Patent Collapse Ball. (4) Shoebootham & Ramsay's Patent Hanks.

99. **LINKLETER, MEARS, W. F.**, 47 Prant Street, Tynemouth.—Improvements in twin-boats, deck seats, life-buoys and marine drags. (2) Boats, folding, and collapsing. (3) Seats, folding and double, automatically or otherwise, saving life rafts. (4) Buoys, fitted with convertible into sail or signal.

100. **BATHMAN, WILLIAM**, 90 Cannon Street, London, E.C.—The Nelson Paint.

101. **YOUNG, C. S.**, 90 Wills Street, Birmingham, near Birmingham.—A Movable Life Hold for passengers.

102. **RAYNER, ROBERT**, 121 Skidmore Street, Mile End, London, E.—Improved Boats for saving life at sea.

999. **TYBAC, G.**, Cookson's Quay, South Shields.—Patent Weldless Anchors, and means for weighing, berthing, and letting go anchors, without crane, davits, blocks, falls, stoppers, &c.

999. **BLAKE & SON**, 115 High Street, Gosport.—Improved Bracket for ships' davits, fitted with davit and blocks.

999. **EMANUEL, HENRY**, Croft Lodge, Surbiton, London, S.W.—Improved plan for attaching boats' or vessels' rudders. [Patented.] This patent substitutes a continuous spindle between the rudder straps and a slotted barrel on the boat, for the ordinary pintle and gudgeons; so that a rudder may be shipped aloft under any conditions of weather, or sea, or after dark. It also prevents the rudder unshipping in a sea-way if the boat take the ground aft. Barrel-made in hard-drawn tube, of special [registered] design, in phosphor-bronze, delta metal, and steel. A propeller shaft disconnecter. Telescope helm, and bilge emptying valve.

999. **LIARDET, L. E.**, 15a London Street, Fenchurch Street, London, E.C.—Detaching and Hooking-on Apparatus, for ships, boats, &c.

999. **JOHNSON, THOMAS**, Gun Lane Saw Mills, Limehouse, London, E.—Improvements in the construction and arrangement of sleeping berths for dormitories, sailing and steam ships, troop ships, and other vessels. An arrangement to ensure a greater amount of privacy for married emigrants, economy of space, promotion of cleanliness, better ventilation, and enables the surgeon superintendent on board emigrant vessels to carry out the rules for good government.

999. **WILSON, J. S.**, 47 Northbrook Road, Southampton.—Improved Davits and Detaching Gear for ships' boats.

999. **MARSHALL, E., & CO.**, 50 Payne Street, North Shields.—Patent Automatic Detaching and Safety Locking Attaching Gear for ships' boats.

999. **CHADBURN & SON**, Telegraph Works, Waterloo Road, Liverpool; 69 Anderston Quay, Glasgow; and 105 Fenchurch Street, London, E.C.—Improvements in ships' telegraphs.

999. **GALES, WILLIAM HENRY**, 50 High Street, Poplar, London, E.—Improvements in ships' and mooring anchors.

999. **LANGLEY, GEORGE**, 47 Bramah Road, Brixton, London, S.W.—The Improved Martin Anchors, Admiralty and commercial patterns.

999. **KEMP, S.**, 8 Holbeck Road, Kennington, London, S.W.—Improvements in deep-sea fishing or trawling apparatus. (4) Separate inventions appertaining to trawling.

981. **HOPPER, R. A.**, Glebe House, Stockton-on-Tees.—Patent Ship Hatch Tar-paulin Fasteners.

982. **COCHRAN & CO.**, Patent Boiler Manufactory, Birkenhead.—Improved Doors for bulkheads and bunkers of war ships and merchant ships.

983. **KING, G. R.**, Pier Road, Gores-ton.—Storm Drift Anchor for saving ships and life at sea.

984. **NELSON, JAMES**, 1 Mount Charles, Belfast.—Apparatus for raising, lowering, and disconnecting ships' boats, by means of which one man can, in one minute, lower and disconnect a ship's boat clear of the vessel's side, ensuring safety to boat and lives in any emergency at sea.

985. **VERNEY, CAPTAIN, R.N.**, Travellers' Club, Pall Mall, London, S.W.—Chain Cable Compressor, where great power is obtained by the employment of an eccentric.

986. **WOOSNAM, C. F.**, Southend-on-Sea, Essex.—Patent Stowaway Rowlocks.

987. **WARRINGTON, H. J.**, Victoria House, Queen Street, Maidenhead.—The Mariner's Friend, an apparatus for converting sea water into fresh, to be used in case of shipwreck.

988. **OULD, R. F.**, 31 Woodstock Road, Poplar, London, E.—Improvement in anchors.

989. **NICOL, MAC NICOLL**, 6 Dixon Street, Glasgow (Agents, C. ATKINS & NISBET, 1 Water Lane, Great Tower Street, London, E.C.)—Improvements in Ferry-boats, enabling heavy traffic to be carried safely across tidal rivers, &c., at quay level, without costly machinery.

990. **ROYAL BLIND ASYLUM & SCHOOL**, 58 Nicolson Street, Edinburgh.—Improved Fitted Berths and Bedding, consisting of spring mattresses, hair, kapok, wool mattresses, bolsters, and purified feather pillows, for Ocean Steamships.

991. **DUNSTON ENGINE WORKS CO. (THE)**, Dunston Engine Works, Gateshead-on-Tyne.—Archer's Patent, Self-holding, Hand Steering Gear and Compressors for holding steel hawsers, and Wrought-Iron Reels and Winches for holding steel hawsers.

992. **COPELAND & LACEY**, 19 Gracechurch Street, London, E.C.—(1) Patent improved method of getting communication between two objects at sea. (2) Patent Blocks. (3) Improved Domestic Fire Escape. (4) Improved method of throwing lines without explosives.

993. **BAXTER, S. & CO.**, 18, 19 Great St. Helen's, London, E.C.—(1) Anchors and Seatings for same. (2) Means for weighing anchors. (3) Capstans.

994. **WILLIAMS, A. H.**, 135 Fenchurch Street, London, E.C.—Raft Seats for saving life at sea, and other life-saving appliances for river, lake, and sea.

995. **STARNES, J. S. & SONS**, 13 Broad Street, Ratcliff, London, E.; and The Platform, Fenchurch Street Station.—(1) Fresh Water Distillers for ships' use, for making any desired quantity of pure water. (2) Improved Ships' Ventilators.

996. **WALL, J.**, 46 Marsh Lane, Bootle, Liverpool.—Apparatus for Signaling.

997. **HUGHES, GEORGE**, Temple Works, Temple Street, Wolverhampton.—(1) Improved Patent Appliance to supersede the use of lanyards and dead eyes, for rigging ships' or boats' masts. (2) Patent Taper Tubular Stanchion for surrounding spar-decks. (3) Patent Ball Bearing Boxes for block or pulley sheaves. (4) Patent Bracketed Pintle, to receive the hinges of cabin or gangway door.

998. **BROWN, E. J. P.**, 112 Snargate Street, Dover, Kent.—Boat-lowering and Disengaging Gear, Rowlocks.

999. **BALCH, WILLIAM**, 4 Romney Terrace, Greenwich, Kent.—(1) Appliances for sounding at sea by electricity. (2) Signals for avoiding collisions. (3) Distress Signals. (4) Life Buoy Night Signals and Shark Protector. (5) Appliance for steering by electricity. (6) Improved Time Glass for heaving log. (7) Boat's Disengaging Gear. (8) Automatic Raft. (9) Apparatus for firing distress signals. (10) Fuse for ensuring the bursting of shells, &c.

1000. **WILKIE, J. B.**, 45 King Street, North Shields.—Apparatus for saving life and property at sea, called a collision hole stopper, for stopping holes in ships or similar vessels, &c.

1001. **SEARLE & SONS**, Stangate, Lambeth, London, S.E.—(1) Fishing Boats. (2) Model of a Water Velocipede with all the latest improvements, for two operators and three passengers.

1002. **KIRKALDY, J. & SON**, 40 West India Dock Road, London, E.—(1) Patent Antifouling Compositions for iron and steel, steam and sailing vessels. (2) Refined Burning Oil, Engine Oil, and Cylinder and Valve Oil. (3) Interesting collection of Barnacles and other marine growths taken from the bottoms of iron vessels which have not been properly protected.

1003. **MORRIS, C. W.**, Harbour View, Lowestoft.—Patent Revolving Rowlocks and Sliding Tholes for life-saving and general purposes.

1004. **RICHARDSON, J.**, 160 Church Street, North Shields, Northumberland.—Collision Pad and Shield for saving life and property in cases of collision at sea.

1005. **ROBERTSON, E.**, St. Peter's

Ship Yard, Ipswich.—(1) Small Model showing belt for lessening the effects of collision. (2) Hand or Steam Elevators for loading or discharging corn or seed. (3) Patent Rowlocks.

1006. **BURGOINE, C. & A., Kingston-on-Thames; and Hampton Wick, London, S.W.**—Model of a Thames Sailing Gig, fitted with seat.

1007. **DAVIS & CLOW, St. Helen's Works, Abingdon, Berks.**—Steel Launch. The frames and plating are of mild steel. Engines consist of pair of direct acting non-condensing type, diameter of cylinders $3\frac{1}{2}$ in. by 18 in. stroke, all working parts of steel and all bearings of phosphor-bronze. Boiler of the locomotive type, of steel with brass tubes. The whole of the decks and fittings are of teak; speed 9 miles per hour.

1008. **JESSOP, WILLIAM, & SONS, Limited, Brightside Works, Sheffield.**—(1) Turton's Patent Built-up Crank Shaft. (2) Smith's Patent Flexible Coupling. (3) Samson's Patent of Fracture of special kinds of steel for various purposes.

1009. **BOAZ, WILLIAM, 29 West India Dock Road, Limehouse, London.**—Patent Apparatus for propelling ships and other vessels, stopping or closing leaky boiler tubes without drawing the fires, and cleaning or scraping boiler tubes.

1011. **LOVE, JAMES, 1 Harmer Terrace, Faraday Road, Leyton, Essex.**—(1) Retarding, Buffing, and Subsidiary Steering. (2) Apparatus for ships.

1013. **TAYLOR & NEATE, Medway Works, Rochester, Kent.**—Steering Gear for barges, yachts, and other craft.

1014. **HAYWARD & CO., Prince's Street, Union Street, Borough, London.**—(1) Patent Ships' Lights, various patterns. (2) Patent Self-Locking Coal Shooters.

1015. **DUNCAN, J., 81 Gracechurch Street, London, E.C.**—Model of Steam Steering Gear.

1016. **MELVILLE, W. S., 18 Frederick Place, Bow, London, E.**—(1) Double Collating Tub or Parrel, for preventing chafe on masts, and parting of tie chains. (2) Lifting Gaff, to prevent twisting of jaws, and chafe of spar, and chafe on mast.

1017. **CARPENTER, JAMES, 20 Fleet Street, New Town, Southampton.**—(1) Patent Pedals for triocycles, &c. (2) Bicycle Patent Motive Power. (3) Railway Couplings. (4) Boat Lowering Apparatus.

1018. **HOLLINS, E. H., 147 Walworth Road, London, S.E.**—(1) Buoyant Propeller. (2) Buoyant Propeller for steering and sailing combined.

1019. **WELCH, WILLIAM, 13 King's Terrace, Southsea, Hants.**—(1) Marine Screw Propulsion. (2) Apparatus for propel-

ling, navigating ships, &c. (3) Cement composition, and method of applying and securing plastic cement with iron, &c. (4) Coating & Covering the Surfaces of Iron or Steel Ships. (5) Structures formed of metal plates. (6) Ships and Boats. (7) Improvements in and relating to torpedo-ejecting tubes. (8) Improvements in the construction of ships' hulls; applicable also to torpedoes. (9) Improvements in furnaces and burners for use of hydro-carbon oils and gas, and apparatus therefor.

1020. **LUMLEY, HENRY, 22 St. James's Street, Piccadilly, London, W.**—Patent Rudder. Improvement upon the Lumley rudder.

1021. **ORME, SAMUEL, Chesterton, North Staffordshire.**—Improved Method of propelling boats and vessels.

1022. **MACKENZIE, H. S., Penwenack, Falmouth.**—Bifurcated Piston-rod and Cross-head combined, by the use of which shafting can be rotated from any point in its length, instead of as at present only by cranks at the ends, or by belting, and cog wheels; also concentric shafts [a solid passing through a hollow one] can be rotated in the same or opposite directions at uniform or variable speeds, without belting or other gear.

1023. **BRADFORD, MAJOR W. H. K., late 106th Regt., Windsor.**—Improvements in screw propellers.

1024. **CLARK, E. H., Hex House, Starcross, Devon.**—New Method of propelling ships.

1025. **BRITTON, THOMAS, 16 Chester Street, Millfield, Sunderland.**—(1) Models of Britton's Patent Steam Steering Gear, with hand gear combined. (2) Britton's Patent for the prevention of grain and other cargoes shifting when in bulk, also to assist the ventilation of same.

1026. **CAMP, E. G., 2 Grove Park, Redland Road, Bristol.**—Improvements in ships' rudders.

1027. **GIBB, ROBERT, 37 St. Martin's Cottages, Silvester Street, Liverpool.**—Spiral Screw Propeller, giving great reduction of slip, but greatest when compared at a high speed.

1028. **BIDDICK, C., & PENNY, T., Bedford Cottages, Ford Devanport.**—Chain Cable Protector.

1029. **HAYES, EDWARD, Watling Works, Stony Stratford.**—Invention for the improvements in the stern posts and parts connected therewith of screw propeller steam vessels, thereby increasing the speed of vessels, reducing the propelling power required, and dispensing entirely with the circulating pump.

1030. **HEWSON, WILLIAM, 15 Lister Street, Hull.**—Patent Improved Double Ruddered Stern Frame for vessels, for security of life and property at sea.

1032. **HARKER, F. T.**, Stockton-on-tees.—Gun Metal and Iron Propellers, blades from 3 ft. diameter, and with increasing pitches.

1033. **SIMPLEX RUDDER FITTING CO. (THE)**, Walton Road, East Molesey, Surrey.—Patent Simplex Rudder Fittings for boats and other small craft.

1034. **PETRIE, GEORGE**, 1 De Vere Gardens, Kensington, London, W.—Improvements in steering gear and escape valve on steam cylinders.

1035. **MAW, CHARLES**, 12 Aldersgate Street, London, E.C.—Improvements in driving screw propellers of steam vessels.

1037. **HEDICKE, M., & CO.**, 3 Adelaide Place, London Bridge, London, E.C.—Propelling Vessels.

1038. **HIME, LIEUT.-COL. F., R.E.**, Lydstep House, Weymouth.—(1) Wave Propeller, an entirely new method of marine propulsion. (2) Model of a Ship's Hull, showing the position and action of the propeller.

1039. **McLENNAN, J., & R. OWEN**, 84 Finsbury Park Road, London, N.—(1) The Continuous or Endless Serpentine Blade. (2) Steamship Propeller.

JESSOP, WILLIAM, & SONS, Limited, Brightside Works, Sheffield.—(1) Crucible Cast Steel Stern Frames and Solid Rudders. (2) Crucible Cast Steel Stern Propeller Brackets and Blades. (3) Turton's Patent Built-up Crank Shaft and solid Crank Shaft made in steel castings. (4) Hall and Verity's Patent Flexible Propeller Shaft Coupling. (5) Hall and Verity's Patent Flexible Crank Shaft. (6) Samples of Fractures and Test Pieces, &c., of special kinds of steel for various purposes.

ASBESTOS CO., Limited (THE UNITED), 161 Queen Victoria Street, London, E.C. (See Group IV.)

BEZER, HENRY, 12 Teddington Park Road, Teddington. (See Group XII.)

BROWNLEE & CO., City Saw Mills, Port Dundas, Glasgow. (See Group III.)

BRYCE, JOHN, Charlton Works, Islington Green, London, N. (See Group III.)

BUCKLEY, W., & CO., Patent Piston Works, Millsands, Sheffield. (See Group IV.)

COCHRAN & CO., Patent Boiler Manufactory, Birkenhead. (See Group IV.)

DANSEY & ROBINSON, Engineers, 14 Gracechurch Street, London, E.C. (See Group IV.)

DAVIS & CO., Limited, 25 Old Jewry, London, E.C. (See Group IV.)

DURHAM, CHURCHILL, & CO., 28 Leadenhall Street, London, E.C. (See Group IV.)

EASTON & ANDERSON, 8 Whitehall Place, London, E.W.; and Erith, Kent. (See Group XI.)

FIELDING & PLATT, Atlas Iron Works, Gloucester. (See Group XI.)

FOX, EDWIN, & CO., Limited, Magnetic Telegraph Wire Works, Millwall, London, E. (See Group XIII.)

HUNTER & ENGLISH, 203 Bow Road, London, E. (See Group III.)

JACKSON, J., 8 Frederick Place, Gray's Inn Road, London, W.C. (See Group IV.)

KIRKALDY, JOHN, 40 West India Dock Road, London, E. (See Group IV.)

MERRYWEATHER & SONS, Greenwich Road, S.E.; and 68 Long Acre, London, W.C. (See Group XI, Queen's Gate Annex.)

PATENT LIQUID FIRE-PROOF CYANITE PAINT CO., Limited (THE), 82 Bishopsgate Street Within, E.C.; and Gunter Grove Works, Chelmsford, London, S.W. (See Group XIV.)

PATENT (METAL) DIE CO., Limited, 29 Addington Street, York Road, London, S.E. (See Group II.)

PATENT NUT & BOLT CO., Limited (THE), London Works, near Birmingham. (See Group III.)

PHOSPHOR BRONZE CO., Limited, 87 Sumner Street, Southwark, London, S.E. (See Group II.)

RENNIE, G. B., 20 Leewards Street, London, E.W. (See Group III.)

ROE, J. T., Earls Villas, Balham Park Road, London, S.W. (See Group I.)

ROSS, LIEUT.-COL. W. A., Acton House, Acton. (See Group XXVIII.)

SISSONS & WHITE, Hedon Road, Hull. (See Group III.)

SMITH, HUGH, & CO., Pencil Works, Glasgow. (See Group XI.)

SMITH, SYDNEY, & SONS, Bassford Brass Works, Nottingham. (See Group IV.)

SNOWDON, JOHN, Thirlwall House, Deronda Road, Herne Hill, London, S.E. (See Group X.)

TULLY, WILLIAM, & CO., 123 Queen Victoria Street, London, E.C. (See Group IV.)

THWAITES, B. H., C.E., & D. B. HEALEY, C.E., 37 Victoria Street, Liverpool. (See Group III.)

UNITE, J., 291 & 293 Edgware Road, London, W. (See Group I.)

WILLANS & ROBINSON, Ferry Works, Thames Ditton, Surrey. (See Group IV.)

GROUP VIII.—AERONAUTICS.**EAST GALLERY ANNEXE.**

[For *Observing Instruments*, see Group XXVIII.;
for *Apparatus for Balloon Photography*, see
Group XXIX.]

1046. **PICHLER, S. FRANCIS**, 162 Great Portland Street, London, W.—Model of a Flying Machine.

1047. **JAY, ROBERT CHARLES**, 41 St. Luke's Road, Westbourne Park, London.—Flying Machine and Apparatus.

1048. **DE MARIA, SALVATORE**, Salita Pirozzoli 10, Naples.—Balloons with governor by sail and an electro-magnetic machine.

1049. **DALE, WILLIAM**, 1 Chester-ton Road, Plaistow, Essex.—Balloon anchor.

1050. **SPENCER, CHARLES ALLEN**, 14 Ringercroft Street, Holloway, London, N.—Improvement in the construction of balloons, and aeronautical appliances.

1051. **GRAY, PATRICK LEITCH**, Freeland, Ratho, N.B.—Factories and other High Chimney Climber.

1052. **HOLLANDS, SYDNEY H.**, Lock Villa, Lock Street, New Bromp-ton, Chatham.—(1) Aero-Dynamometer; machine designed to gauge relative wind

pressure, vertically and horizontally, on inclined Aero-planes, at various inclinations and velocities. (2) Steam Aviators or Steam Flying Engines. [Models and Scale Drawings.]

1053. **McKEE, HENRY**, 1 Custom House Square, Belfast.—Screw-propelled Aeroplane.

1054. **HIME, LIEUT.-COL. FREDERICK, R.E.**, Lydstep House, Weymouth.—(1) Wave Winged Flying Aerial Propeller—(2) Working Model showing the propelling effect of wave motion in wings.

1055. **MOY, THOMAS**, 8 Quality Court, Chancery Lane, London, W.C.—(1) Photograph, Aerial Machine. Experiment with model driven by steam power in June, 1875. (2) Model Aerial Machine, tried 18th March, 1879, when it raised itself from the ground by its own velocity.

CUSWORTH, C., 30 Ellington Street, London, N. (*See Group XXIX.*)

ORCHARD, JOHN, 100 High Street, Kensington, London, W. (*See Group XIV.*)

HOWELL, G., M.D., Falcon Road, London. (*See Group XXV.*)

ROSE, J. T., 3 Earls Villas, Balham Park Road, London, S.W. (*See Group V.*)

WETHERED, LIEUT.-COL. E. R., 100 Herbert Road, Woolwich, Kent. (*See Group XXIV.*)

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MANUFACTURE OF TEXTILE FABRICS.

BY SWIRE SMITH, ESQ.

EARLY HISTORY OF TEXTILE MANUFACTURES.

In order to appreciate the importance of the inventions and improvements in textile machinery, and the progress of the textile industries during recent years, it is desirable briefly to review their growth and development from the period of their introduction into these islands until the present time.

The chief fibres which form the raw materials of the textile products are Cotton, Flax, Wool, Mohair, Alpaca, and Silk.

In their early history the processes of Spinning and Weaving were carried on entirely by hand, and none of the textile industries, which have contributed so enormously to the commerce, wealth, and population of the United Kingdom, were indigenous to these islands.

So far as can be traced, India was the earliest seat of the cotton industry, and monopolised the manufacture of cotton fabrics for several centuries after intercourse had been established by the Greeks and Romans with that country. Although the rudest appliances were employed in the spinning and weaving, yet the beauty and fineness of Indian cotton fabrics could hardly be excelled in modern times. The cotton industry seems to have been late in its introduction to Europe, for although when Columbus discovered South America he found the natives wearing cotton clothing of their own manufacture, yet from the 10th to the 14th century there is no trace of this industry in any portion of Christendom. The earliest mention of cotton in England is found in the records of the monks of Bolton Abbey in 1298, who imported it for candle-wicks—which, by the way, formed the main trade of the country in the product of this fibre—until the latter half of the 18th century. Flax appears to have been first cultivated in Egypt, and its manufacture is frequently mentioned in the Mosaic records as among the occupations of the people. Wool is claimed by some authorities to be the first of the textile materials used for artificial clothing, and England was an exporter of wool, and a purely pastoral country for centuries before she began its manufacture. “The ribs of people throughout the world,” wrote Matthew Paris, “are kept warm by the fleeces of English wool.” The silk industry was originated in China, and is mentioned as far back as 2700 years before the Christian era. All these important manufactures, Cotton, Flax, Wool, Silk, travelled slowly westward, and, excepting wool, were somewhat late in their introduction to Great Britain. Of these wool was the earliest, and first assumed importance when artisans from the Netherlands—where the wool industry took its rise in the 10th century—were invited by Edward III. to settle in this country. During the persecutions in 1567, and the sack of Antwerp in 1585, England—ever an asylum for the oppressed from every land—offered a friendly home to the banished refugees, who in turn asked for no further privileges than freedom to worship and to labour. Most of them on reaching this country were entirely destitute, “but,” as Dr. Smiles says, “many brought with them that seed of wealth which money cannot buy,—intelligence, skill, virtue, and the spirit of independence. Wherever the refugees took up their abode, they acted as so many missionaries of skilled work—exhibiting the best practical examples of diligence, industry, and thrift, and teaching the people among whom they settled, in the most effective manner, the beginnings of those various industrial arts by which they have since acquired so much distinction and wealth.” A grateful acknowledgment is due to the Flemings and other Continental refugees for their great services in the promotion of British industries at this period.

INTRODUCTION OF THE FACTORY SYSTEM.

Cotton.—Prior to 1760 the cotton machines in use in England were nearly as simple as those of India, and in the other textiles the manufacturing processes were essentially those of the hand. Hand-spinning was universal, and the climax of invention was thought to have been attained at the close of the 16th century, when the “two-handed wheel” was introduced. Pro-

gress during the earlier half of the 18th century was slow. Cards for combing were adapted from the woollen to the cotton manufacture, and some improvements were made in weaving. The fly shuttle, or "picking peg," was invented in 1738 by John Kay, and the drop box by Robert Kay in 1760, thereby greatly increasing the productive power of the loom. But some of the greatest mechanical inventions that the world has ever seen were now in embryo. A machine for spinning by rollers was invented by John Wyatt and patented by Louis Paul in 1738. A patent embodying this principle, called the "water-frame," was taken out by Richard Arkwright in 1769—who also introduced perpetual carding—followed by the "spinning jenny," invented by James Hargreaves and patented in 1770; while a few years afterwards Samuel Crompton united the principles of Hargreaves' "jenny" and Arkwright's "water-frame," and gave to the world the mule-spinning frame. *These inventions, determining the principles of the cotton machinery, laid the foundations of an industrial movement unparalleled in history, and enabled England by utilising her mineral resources to take that dominant position in the world as a manufacturing nation, which from that time she has continued to hold.* From hand labour carried on in cottages, small factories were started, in which horses were introduced to propel the newly-invented machinery. Next came water-power, first brought into requisition for this purpose about 1790. Steam soon entered into the competition, although in the beginning, it was but rudely employed to lift water on to a wheel,—water being considered the only source of regular and steady motive power. It was about the year 1790 that the improved steam engine by James Watt began to be successfully applied to cotton machinery, and thus the factory system, initiated by Arkwright—and so marvellous in its influence upon the destinies of the human race—was matured. The power loom was invented by the Rev. Dr. Cartwright in 1785. Great improvements in scutching, carding and preparing machinery followed. The head stock was placed in the centre of the mule by Wright, while Richard Roberts, about 1825, achieved an enormous step in advance by his invention of the self-acting mule. The lace machine was invented by Heathcote in 1809, opening up a new industry susceptible of producing patterns of infinite complications and great beauty. In fact, it may be said that during the half century covering this period there was a remarkable combination of inventiveness and executive skill in perfecting the machinery, and of enterprise in developing the cotton industry. Calico printing, quickened by the rapidly increasing demand for colour and design, advanced from hand blocks to machine rollers, and from the primitive and laborious methods of hand engraving to the ingenious contrivances of the pentagraph machine, and the application of chemical agencies. Thus the designer, engraver and chemist lent their aid to the spinner and manufacturer in beautifying the fabrics of the loom. Their cheapness and excellence brought them into increasing requisition all the world over, and the cotton trade literally advanced by "leaps and bounds." It is stated that 1000 operatives employed at the present time in a cotton factory accomplish with ease more work than was performed by the whole of the cotton operatives of the United Kingdom, numbering about 43,000, who were engaged in the trade in 1760. The growth in other textile industries has been due to the same causes as have affected cotton, and mainly to the same mechanical inventions. Wool and flax manufactures, no less than cotton, and in some respects silk, were revolutionised by the introduction of machinery embodying the principles established in the inventions of Hargreaves, Arkwright, Crompton, Cartwright, and moved by the steam engine of James Watt. It should not be forgotten that these men—among the greatest of the world's benefactors—were Englishmen, and that all the great inventions that laid the foundation of the cotton industry, and raised it to its present magnitude, have been of British origin. Important machines for textiles have been invented in other countries; the Jacquard fancy loom was invented by Jacquard, of Lyons, in 1801. The "dead spindle" was of American origin (1831)—the invention of the ring spindle is disputed. The combing machine for cotton was invented by Heilmann, of Mulhouse, in 1846—adapted from his wool-combing machine. With these exceptions there are no inventions or improvements of the first class at present employed in the spinning, weaving, and printing of cotton that are not the outcome of British ingenuity embodied into practical shape by British machine makers.

Coming to more modern times, the Exhibition of 1851 afforded a revelation to the world of the superiority of English textile machinery, and although it is often alleged that we opened the door to the nations of Europe, inviting them to see our treasures and thus despoil the "workshop

of the world," with weapons of our own forging, it is an undoubted fact that the cotton industry in England received its most striking impetus during the period between the Exhibitions of 1851 and 1862, and owing in a great measure to the progress of English cotton machinery. The Exhibition of 1862 demonstrated that our mechanical superiority was still unchallenged, although English machinery had been extensively copied on the Continent and in America. Since 1862 the enterprising machine makers of Lancashire have vied with each other in the application of improvements and inventions resulting in the admitted superiority of recent machinery over that of twenty years ago. But this superiority is due to minor improvements, including great perfection in workmanship, and not to any great deviation in principle from the machinery in use before that time, except in the development of the ring spinning frame. In a brief sketch it is impossible to specify all the improvements, or to name the many contributors whose ingenuity and industry during recent years have brought about the present high perfection of cotton machinery. These improvements are well known to the trade, but cannot be described so as to be understood by the general public. In a few words it may be said that in opening and cleaning machines, feed regulators and "consolidators" have been added. In carding machinery, numerous improvements have been introduced, including the substitution of steel for iron card teeth and the introduction of "revolving card flats," the "oscillating fly comb," and the "web-conductor." The combing machine by Heilmann has changed but little in its principal features since it was originally brought out, and has maintained its commanding position although other valuable machines have been introduced. The combs are now made of eight to ten heads, with stop motions, a cleaning brush, securing greater steadiness and a better nip, with an increase of 50 per cent. of speed and production. In drawing machines, front and back stop motions—some by electricity—can spring motions, loose bossed top rollers, revolving endless clearer cloths, &c., have been introduced with an increase of efficiency and economy in the working. Slubbing, intermediate, and roving frames have been improved by better winding arrangements, stronger spindles, steel flyers, case-hardened rollers, stopping and lock motions, &c. The self-acting mule, although in general construction the same as in 1862, has received so many important additions and improvements as to place it beyond the competition of the mule of that time, in economical production and efficiency. Without entering into complicated details it may be remarked that the working parts of the mule have been much strengthened, some of the important motions have been made automatic, thus relying for precision and action less and less on the skill of the minder, who is thereby enabled to devote his attention to the output of the machine. It is now very common for spindles to run upwards of 8000 revolutions per minute, at the same time bearing up 20 per cent. heavier than those formerly made. The machines work more steadily and quietly, with fewer breakdowns, while their capacity to stand the strain of the extra quantity of work produced is very much greater. As a consequence, although during the last ten years the factory hours have been reduced from sixty to fifty-six and a half, the increase of production per spindle since 1866, of 32" yarn is equal to about 22 per cent.; whilst the quality of the yarn has improved in strength from 8 to 10 per cent. For spinning the finest counts a number of delicate and sensitive motions have been adopted, by which the self-acting mule is rapidly superseding the hand mule, which, however, is still extensively retained for very fine spinning. In the production of yarns of medium counts, there has recently been in this country an important increase in ring spinning and ring doubling. The ring frame is very extensively used in the United States, where it is held in high esteem. Unquestionably it is the most effective of spinning machines, and within the last few years has been greatly improved. The spindles in these machines are the outcome of American experience, the most popular being the "Rabbeth."

In looms there have been no great inventions during the last few years, but the loom of today, notwithstanding, is a vastly superior machine to that of twenty-five years ago, and is constantly being improved in detail. In figured weaving, of which there is comparatively little in cotton, elaborate and extensive patterns may be woven with a greatly reduced number of cards, and great improvements have taken place in shuttle boxes, stop motions, web forks, samples, &c., while in consequence of superior workmanship greater stability has been given to the working of the loom. The value of these improvements is shown in the higher speed of the loom, and in the fact that a single operative is able to mind four, in place of two a quarter of a century ago. It is also satisfactory to find that effective contrivances have been introduced

to prevent "shuttle flying," thus reducing accidents which a few years ago were of alarming frequency. This latter improvement applies to all power looms in the textile industries.

Lace.—The lace trade, which has always been centred at Nottingham, has shown remarkable progress since the era of machinery. The net twist lace machine, invented by Heathcote in 1809, was a marked improvement on all the modifications which had followed the loop machine, or stocking frame of William Lee in 1580. The machine now extensively used represents many improvements by John Leavers and others on Heathcote's patent. A great stimulus was given to the lace trade by the application of Jacquard's invention in 1837 to the warp machine, and in a short time afterwards to the twist lace machine. At that time 150,000 persons were employed in embroidering the figures and patterns on the woven net by hand, but through the adoption of the Jacquard the labour of all these hand embroiderers was ultimately superseded. Improvements followed each other in rapid succession from this period, while since 1846 the machines—still retaining original principles—have been remodelled almost every ten years. Peddie's machine, invented in 1840, was adapted for making lace curtains about twenty years ago, and is in some instances from 200 to 300 inches wide. Nottingham, by its skill and enterprise in the application of mechanical improvements, and not less by the cultured taste displayed in its designs, and in placing them upon the woven fabric, has continued to maintain its supremacy in spite of all foreign and native competition. The lace machinery of this town is at the present time distributed over the world, and although out of a total of 1044 of the most elaborate of the curtain machines 700 are in Nottingham and neighbourhood, and 160 in Scotland,—in view of the cheap labour, superior education and taste of French and German rivals who now work 180 of these machines, the utmost efficiency, economy and vigilance will be required on the part of home manufacturers, or this position will be seriously and rapidly assailed.

From the most recent statistics of factories in the United Kingdom (1879) the following are the figures relating to the extent of the cotton industry:—

	No. of factories.	No. of spinning and doubling spindles.	No. of power looms.	Total operatives employed.
Cotton ...	2,674	44,206,690	514,911	482,903
Lace ...	283	—	—	10,209

For those desiring information as to the consumption of raw cotton and the export of cotton goods and yarns, the following figures will be interesting:—

	Consumption of cotton in Great Britain. lbs.	Value of exports of cotton goods and yarns. £
1701 ...	1,985,868	23,253
1790 ...	31,447,605	1,662,369
1860 ...	1,083,600,000	52,012,380
1884 ...	1,481,600,000	72,736,000

Flax.—The cultivation of flax was practised in Ireland in early times, but the first impulse to its extended growth and manufacture was given by Huguenot families expelled from France in 1685. The mechanical spinning of this fibre in England began with the adaptation of the previously invented cotton machinery, about ten years before the end of the 18th century. Hackling, or dressing the flax by machinery instead of by hand, was introduced in 1808. The greater length and the smaller amount of cohesion of the fibres made it necessary that flax should be drawn through gills or combs, which were introduced and perfected between the years 1818-1835, along with other improvements by the Leeds School of Engineers and Mechanicians. One characteristic of flax spinning, distinguishing it from other fibres, is that for all fine yarns the material is passed through hot water to soften the gummy substances in it, and to enable the fibres to be drawn out easily and uniformly to a fine thread. This process—wet spinning—was brought into practical working in 1827.

These three operations, hackling, gill drawing, and spinning, remain in principle the same as at the time of their introduction. The improvements of the last twenty-five years have affected details rather than principles. There has been a constantly increasing accuracy in the building of the machinery, reducing the labour of minding the machines, vastly improving the

character of the produce, and enabling the spinner to put the same material to much finer purposes. The same description applies to looms in which there have not been any recent inventions of special importance.

Hemp and Jute.—The fibres resembling flax most closely—hemp and jute—are prepared in a similar way; hemp is spun like flax, either wet or dry, while jute is spun dry, but with a slight dressing of oil. The mechanical improvements in flax embrace these fibres also.

The factory return of 1879 gives the following figures relating to the above industries:—

	No. of factories.	Spinning and doubling spindles.	Power looms.	Operatives employed.
Total of Flax ...	400 ...	1,329,748 ...	40,448 ...	108,806
„ Hemp ...	58 ...	25,304 ...	74 ...	4,780
„ Jute ...	117 ...	220,168 ...	11,288 ...	36,354
TOTAL FLAX, HEMP & JUTE ...	575 ...	1,575,220 ...	51,810 ...	149,940

The mills of this country consume about 20,000 tons of home-grown flax, in addition to an annual import of from 80,000 to 90,000 tons, and a quantity of hemp which may be estimated at about 10,000 to 12,000 tons—used for coarse linens, shoe-threads, &c.

HISTORICAL SKETCH OF THE WORSTED TRADE.

Wool.—The wool industry was the first of the textile arts to be introduced into Great Britain. The Flemings, who had been the chief manufacturers of the wool exported from England, began the manufacture of worsteds at or near Norwich early in the 14th century. So important did this industry become that, at the close of the 17th century, it is stated that the production of wool and its manufactures constituted the “most solid foundation of the national prosperity and riches.” At a time when the annual rental of the land amounted to £10,000,000, and the annual income of the State to £43,000,000, the annual value of wool and its manufactures was estimated at £8,000,000. Thus the merchandize produced from wool amounted to nearly one-fifth of the annual income of the realm, and almost approached the rental of the land (James’s ‘History of Worsted Manufacture,’ p. 182). At this time Norwich was the largest city in the kingdom next to London, and was described by Macaulay as “the chief seat of the chief manufacture of the realm.”

MODERN FACTORY SYSTEM APPLIED TO WOOL MANUFACTURES.

The modern system of wool manufacturing, like that of cotton, began with the inventions of Hargreaves and Arkwright, aided by the introduction of the steam engine. Norwich for a time continued to be the acknowledged wool centre, but during the 18th century the Piece Halls of Halifax and Bradford, and the Cloth Halls of Leeds and Huddersfield were erected as markets for the disposal of woven goods and yarns, principally made in Yorkshire. The first worsted factory was erected in 1784 at Dolphin Holme, near Lancaster, and the first in Bradford in 1793, where spinning machines on Arkwright’s principle were started. From that time machinery extended rapidly in Bradford, Halifax, and other Yorkshire towns, although trade was placed in constant peril by strikes and riots, which broke out on the introduction of every mechanical improvement dispensing with hand labour. These demonstrations, however, were successfully resisted in the north, but in Norwich there was a manifest refusal on the part of those most interested, to depart from the antiquated methods of the past, although hard pressed by competition. For any one in the beginning of the present century to attempt to set up machinery in Norwich was to venture his life. This policy stripped the illustrious city of its manufacturing prestige, but the tide of progress could not thus be stayed, and many of the misguided and distressed artisans were glad to accept employment in northern towns as minders of the very machines whose admission to their own city they had so blindly and resolutely refused.

Power looms were introduced into the worsted trade about the year 1825; the Jacquard loom in 1827. In 1831 the “dead spindle” (cap spindle) was brought over from America, and the screw gill was applied by Fairbairn, of Leeds, in 1834. The spinning of alpaca, mohair, &c., was overcome by Titus Salt in 1836, and cotton warps were introduced at about the same period. Hitherto nearly all the wool used in the worsted manufacture was combed by hand. Dr. Cartwright had

invented a combing machine in 1790, but little was known of it. Other machines followed, the most important of which was Heilmann's, invented in 1846. A combing machine by Lister and Donisthorpe was introduced in 1850, but its working was stopped by Heilmann on account of an alleged infringement of his patent. In 1852 the patent-right for England of Heilmann's wool machine was purchased by E. C. Lister, of Bradford, for £30,000, who improved it in various ways, thus superseding hand combing, and giving a marvellous impetus to the long wool industry. Isaac Holden's combing machine was invented in 1850, and being especially adapted for fine Australian merino wools exerted an influence, still more remarkable, over the product of a wider field. The combing machine by James Noble, with which Donisthorpe was associated, was invented in 1854, and has since enjoyed a constantly increasing reputation as being adapted for varied qualities of wool of long and short staple.

As in cotton there have been no inventions that have changed the character of worsted machinery since the Exhibition of 1862; yet the improvements in detail have been numerous and important, materially increasing the efficiency of several machines and lessening the cost of production. Wool washing and drying have been facilitated by a number of automatic appliances, satisfactorily minimising hand labour. Carding engines have been improved by the substitution of steel for iron wire, and by the addition of an important automatic feeder—an American invention. Preparing machines have been fitted with double screw gills and fallers, greatly lessening the liability of breakage of the fibre in being drafted from back to front rollers. A number of patented improvements have been added to combing machines, particularly to Holden's and Noble's, enabling the production to be increased, with better work, and a reduction in noll and waste. New combing machines have been invented, of which may be mentioned those of Hill and Eastwood, and Jefferson.

In drawing machinery the rubber system from France has been introduced by one of the largest machine makers, for preparing fine combed Australian and other wools for mule spinning, and important modifications have been made in English "open drawing," for spinning the same wools on cap frames. In worsted spinning, mules have again been introduced by some leading spinners, after having been in a great measure discarded forty years ago in this country in favour of cap frames. For competing with "rubber drawing" and mules in the spinning of the finest and the shortest stapled wools, the modifications in the English system of open drawing, though they have been confined to matters of detail, are of commanding importance, inasmuch as they are securing efficiency and economy of production. In addition to the above re-introduction of mule spinning, and the more effective manipulation of fine wools by open drawing and cap frames, there have been several patents for stop motions for the prevention of double yarn in spinning, and single in twisting, patent caps for mohair bobbins, and other details. Ring spinning has also been introduced, but the increased roughness of the fibre caused by the speed has militated against its general adoption. For dealing with this difficulty an improved patent ring cap enables the spindle to be run at a greatly increased speed in the production of yarn of medium quality, without seriously increasing the roughness of the fibre, and the same result is obtained in a high degree by a patent combination of ring and cap recently introduced.

Looms.—The improvements in worsted and woollen looms are too numerous and too detailed for specification in this sketch. The power loom twenty-five years ago was a machine that could be imperfectly adapted for weaving a variety of styles of fabric on the same loom; but since that time there has been a great sub-division in weaving, looms being now specially constructed for given styles and patterns. The changes have amounted to almost a revolution in certain power looms, many of the parts working automatically and with wonderful precision. In Jacquard and Dobby weaving, so great have been the improvements that certain makers claim to be able to weave by power any pattern that can be woven by hand. Speed has been increased since 1862 from 120 picks to 180 and 200 picks per minute. In worsted coating looms the race for improvements is still rapidly continuing. At the present time cloth can be made which it was impossible a few years ago to weave in a power loom; and while within half a dozen years, coating looms were generally making fewer than 50 picks per minute, they are now making 80 and 90 and doing better work.

Woollen.—The difference between "worsted" and "woollen" is mainly a difference in machinery and in the subsequent treatment of the woven fibre. A worsted yarn may be defined as a thread spun from wool, the fibres being arranged so as to lie smoothly in the direction of the

thread and parallel to each other. A woollen yarn is a thread spun from wool, the fibres being arranged so as to cross and overlap each other, and to present their serrated surfaces in the greatest variety of ways. Worsted yarn is usually combed; woollen yarn is invariably carded, and, with a strong disposition to "felt," is generally milled or felted after weaving, thereby causing the fibres to interlock as much as possible, thus producing opaque woollen cloth.

The history of the woollen trade in early times coincides with that of worsted, owing its chief development to the various immigrations of weavers, &c., from the Netherlands and France. From the period of the mule and the steam engine, the factory system gradually became established and centred at Leeds and Huddersfield, although there are important seats of woollen manufacture in Gloucestershire, Wiltshire, Norfolk, and in Scotland. During the early part of the century improvements were adopted in carding, and the condenser was introduced. Prior to 1862 the self-acting mule was only exceptionally employed in English woollen factories, and in its adoption the English have lagged behind the Belgian spinners. It is said that to this cause may be partially attributed the firm foothold of Belgian yarns in this country, the import of which amounted in 1888 to 11,453,000 lbs. During the last twenty-five years there have been no important inventions in woollen machinery, but the Exhibition of 1862 gave a great impetus to the introduction of minor improvements, and was the date of greatly increased enterprise in the trade. Iron has been substituted for wood in winding engines, and steel for iron wire. Automatic card-feeders have been introduced; the old "killy" has been superseded by an improved condenser, and the self-acting mule is now almost universally employed. Economies and labour-saving appliances have been carried into all the details of production, and the hand loom, which a few years ago was worked in the cottage, has been generally supplanted by the power loom in the factory.

Carpets.—In the carpet industry a important revolution took place some fifty years ago when printed warps were introduced. This was followed by the adaptation of the power loom to weave Brussels, Tournay velvet, Tapestry, and Tapestry velvet carpets. The hand loom has been further replaced by the power loom, which has been applied to the production of Scotch or Axminster carpets equal in variety, colour, design, and texture to the products of the hand loom. The power loom is now used for the weaving of chenille, of Axminster carpets, and of "Royal" Axminster carpets, woven on the patented American loom, brought out in 1877. Improvements in detail have led to an increase of speed in tapestry looms of from 60 to 70 per cent, and to the construction of power looms of greatly increased width, whereby carpets can now be produced in pieces four yards wide.

Other branches of the woollen industry, such as the manufacture of flannels, blankets, &c., have profited by the general advance of woollen machinery.

Shoddy and Mungo.—The shoddy and mungo trades form probably the most remarkable illustrations of the utilisation of waste products to be found in the textile industries. Old clothes, woollen rags, worn-out stockings, any scraps of fabric containing wool, are "extracted," worked up, and manufactured into cloth. "Shoddy" is made from old stockings, flannels, stuffs, &c., known as "softs." "Mungo" is made from tailors' clippings, old clothes, ground rags, &c., known as "hards." "Extract" is the wool derived from rags and other materials in which cotton or linen has been mixed with wool in its manufactured state. The waste product from the above is "flocks," in appearance often little better than dust. In the marvellous economy of the wool industry, every vestige of woollen material is sought up and utilised, and it is saying in the district of Yorkshire, where this industry is carried on, that "any fibre can be spun if it only be long enough to have two ends." Waste which seems little more than a pile of dust can be mixed with a small proportion of wool, and made into handsome, warm, and really substantial cloth. The shoddy trade dates as far back as 1818, beginning at Batley and Dewsbury in Yorkshire. Its full development took place between 1840 and 1860, and has continued to grow in much the same ratio to the present time. An important departure in this industry has been the union cloth manufacture, so called from the union of cotton warps with woollen weft, producing in many instances a cloth in which the cotton is so completely buried in the wool, that only an expert can tell the difference between the all-woollen and the mixed fabric of similar appearance. The shoddy trade for many years was frowned upon as a spurious adulteration, but it is now one of the acknowledged benefits to the world, inasmuch as it enables millions in our own and other countries to procure warm and suitable articles of clothing which

in former days were beyond their reach. It is said that 125,000,000 lbs. of shoddy, mungo, &c., are manufactured into cloth every year in England alone.

The mechanical and chemical improvements in this industry during the last twenty-five years are too numerous to specify. Among these are the "wet" and "dry" systems of extracting; the "opener" has been greatly improved, the machine being locally known as "the Devil," from the effective way in which it tears up and maltreats whatever it gets hold of. The card-feeding machines, by which the raw material is regularly and automatically supplied, and the condensing ring doffers are great improvements upon old methods, while the tentering machines for finishing have promoted efficiency, economised labour, and secured greater cheapness of production.

Hosiery.—Hosiery has shared with other textiles in the extension of its industry. The circular frame, invented in 1849, gave a great impetus to knitting by power in Leicester. The "tumbler" or "latch needle" was invented a few years later, enabling fancy coloured striped stockings and ribbed fabrics to be produced almost as cheaply as plain ones. For so-called fashioned, i.e. shaped articles, of hosiery the hand frames of thirty years ago have been superseded by "rotary" frames, run by power, invented about 1857, and greatly improved since that time. The most important of these improvements was added in 1864,—a rotary frame being patented embodying all the main principles of the original stocking frame, yet increasing the speed by 50 per cent., while requiring much less power. This machine, by a series of patented inventions, has been brought to a high state of efficiency, and now produces work fully fashioned,—narrowing, widening, strengthening where necessary—yet performing these delicate manipulations automatically. By the above and other mechanical improvements there has been a large development effected in the hosiery trade of Leicester and neighbouring towns, knitted goods having been cheapened in production, while the average wages of operatives have been almost doubled. At the present time there seems to be no abatement in the growth of this industry.

The following table shows the development and progress of the wool industry, exclusive of shoddy and mungo, during the present century:—

CONSUMPTION OF WOOL IN THE UNITED KINGDOM.						
	Estimated yield of English wool.		Imports of Foreign and Colonial wool.		Exports.	Consumption.
	lbs.		lbs.		lbs.	lbs.
1800 ...	96,000,000	...	9,000,000	...	—	105,000,000
1850 ...	130,000,000	...	77,000,000	...	26,000,000	181,000,000
1862 ...	140,000,000	...	176,000,000	...	58,000,000	258,000,000
1884 ...	132,000,000	...	544,000,000	...	295,000,000	381,000,000

The official statistics from the return of 1879, relating to worsted, woollen, and shoddy, and other factories, are as follow:—

		Number of factories.		Total number of spinning & doubling spindles.		Number of power looms.		Number of operatives employed.
Worsted Factories	...	693	...	2,552,934	...	87,893	...	130,925
Woollen Factories	...	1,732	...	3,655,761	...	56,944	...	134,344
Shoddy Factories	...	137	...	92,984	...	2,110	...	5,079
Hosiery Factories	...	186	...	—	...	—	...	14,992
Hair Factories	...	36	...	—	...	—	...	1,731
Elastic Factories	...	83	...	—	...	—	...	4,438

*Silk.**—The silk industry remained for a longer period comparatively uninfluenced by the great inventions of Arkwright, &c., than the other leading textiles. This was partly due to the fact that raw silk, in the form of reeled yarn, has always been imported in a condition ready for the throwster to prepare into organzine (warp), or tram (weft), for the dyer and weaver. The Jacquard loom was introduced into Coventry in 1823. The first power loom factory in the same town was burnt down by a mob in 1831, and another was erected in 1838. The vicissitudes of the silk trade, although of more or less melancholy interest, have not been materially affected by mechanical inventions. Improvements have been kept back by the periodical conflicts between employers and employed, and intense suffering has often been the consequence. The trade has languished in Spitalfields and Coventry while it has flourished in Switzerland and

* For full particulars relating to silk, see a report of the English Silk Industry, by Thos. Wardle, &c., &c., in the Second Report of the Royal Commissioners on Technical Instruction, Vol. III.

Germany, and its general record of mechanical inventions and improvements during the present century contrasts very unfavourably, so far as this country is concerned, with the other textile industries which are here brought briefly under review. There have, however, been marked examples of enterprise and success in the experience of individual firms.

"Spun Silk" and "Schappe."—Within recent years new branches of the silk industry, called "spun silk" and "schappe," have sprung up, which demand a brief mention. "Spun silk," from which the natural gum is thoroughly discharged, is mainly produced in England, while "schappe," from which the gum is only partially discharged, is chiefly prepared and spun in Switzerland, France, and other continental countries. In the operations of producing silk, yarn from the cocoon a great quantity of silk waste is made. Many of the cocoons suffer from imperfect formation, or are crushed, torn, and otherwise spoiled, and thus cannot be reeled, and have to be cast aside as waste. In all the subsequent operations—in reeling, throwing, winding, weaving—waste is made, which in former times was thrown away as of no value. The modern manufacturing economist has seized this refuse, cleansed it from its impurities, applied to it the carding, combing, and spinning machines, modified from those employed in cotton and wool, and has built up a new silk industry which at this time in England is of greater importance than the trade in pure silk, whether regarded as illustrating the spirit of inventiveness and enterprise, or as representing the quantity of product, capital invested and operatives employed.

Of the inventions in silk machinery during the last twenty-five years the most important have been patented by S. C. Lister, of Bradford. His silk comb, patented in 1859, enabled him to utilize the waste silks of India, which at that time were quite useless, and of which he had a monopoly for many years. From this waste, at one time offered in London at $\frac{1}{4}$ d. per lb., and treated as manure because it would not rot, a yarn was made which was sold in Crefeld, in Germany, and other places, at from 20s. to 24s. per lb., and the same material, now worth from 3s. 3d. per lb., is made into yarn at from 11s. to 12s. 6d. per lb., and into velvets which in their finished state (24 inches wide) sell at 8s. per yard. A self-acting dressing frame was patented by Lister within the last ten years, the only one in existence, followed by the velvet power loom, by which six pieces of velvet plush can now be woven in one operation. The importance of these inventions will be appreciated from the fact that in perfecting them and in the accessory machines have been expended no less than £300,000. The waste silk manufactures are now reckoned among the most attractive and valuable within the range of the textile arts; and although the pure silk industry of England compares unsatisfactorily with that of rival countries, it is consoling to record that England stands first in its mechanical inventions for dealing with this new industry—which has doubled during the last twenty-five years—and that the largest and most important silk works in the world are those of an Englishman.

The statistics of silk factories, &c., in the United Kingdom from the return of 1879 are as follows:—

	No. of factories.	No. of spinning and doubling spindles.	No. of power looms.	Total operatives employed.
SILK	706	918,939	12,546	40,985

Appended is a summary of the textile factories of the United Kingdom from the official returns of 1879. It is necessary to state that these returns were collected during a period of unexampled depression, when there were 254 factories entirely closed, the particulars of which are not included:—

	No. of factories.	No. of spinning and doubling spindles.	No. of power looms.	Total operatives employed.
TOTAL TEXTILE FACTORIES ...	7105	53,102,528	725,714	975,546

CONCLUSION.

Comparison with Foreign Rivals.—Still ahead in Cotton.—Supremacy will be contested.—Technical Instruction needed in Calico Printing.—Superiority of Foreign Designs.—Jute.—Linen.—Evidence of Belfast Manufacturers.—Foreign Competition in Worsted Goods.—Silk Trade unsatisfactory.—Nottingham keeps its Position.—Imports of Foreign Goods unsatisfactory.—Not caused by Cheap Labour.—Superior Taste in Foreign Goods.—Technical Schools Abroad.—Technical Schools in England.—City Companies.—South Kensington Department.—Nation needs Awakening.—Future Prospects.

In concluding this brief sketch of the leading textile industries and their remarkable development during recent years, it is necessary to state that it is not in machinery alone that

vast progress has been made. The operatives in our great industries have fairly kept pace manual training with the improvements in machinery, although their scientific and artistic instruction has been seriously neglected. Of the cotton operatives in particular it may be said that they work with intelligence, energy, and endurance, unequalled by their competitors in any other country, and while in some other industries our operatives may be equalled in ordinary manual dexterity by some of their foreign rivals, yet by none are they surpassed. The sanitary condition of factories, the appliances for health and comfort, for the guarding of machinery, & so as to reduce the risks of accidents are matters which receive consideration everywhere in the textile districts. The Registrar-General's returns testify to the increased longevity of the factory operatives, and their improvement in health and physique is everywhere apparent.

Wages are considerably higher than in any country in Europe, and hours of labour are fewer than in any country in the world; and taking the cotton trade as an illustration in which more definite comparisons may be made than in any other of the textile industries, it is certain that in absolute economy of production the English cotton manufacturers know no rivals. The prophecy has been unweariedly repeated that England's manufacturing supremacy being due to the monopoly of the great mechanical inventions of the last century, with the distribution of English machinery in countries where lower wages prevailed this supremacy would cease. The facts of to-day scarcely bear out this prophecy. It is true that the great inventions of Arkwright, Crompton, Watt, and other distinguished Englishmen are now the property of the human race. In every seat of the cotton industry, whether in the old countries of Europe, India, or among our enterprising relatives in the United States or Canada, English machinery is to be found, in all instances worked under the alleged favourable conditions of longer hours and in all instances, but that of America, of considerably lower wages. In exporting their commodities, British manufacturers have further to contend against the protective tariffs intended to shut out British goods from competing countries, and yet in face of these disadvantages the exports of cotton goods from this country have nearly doubled since the Exhibition of 1862. In a great measure this continued supremacy has been due to British energy and to the general readiness of manufacturers and machine makers to work out and adopt improvements and economies even in the smallest details. The same qualities, however, are rapidly being developed in other countries. In the recent visit of the Royal Commission of Technical Instruction to the manufacturing centres of Europe and America, it was demonstrated that our rivals in several countries, besides possessing the equipment of the English machinery, are rapidly improving in organisation and efficiency, and thus becoming formidable in their competition.

There is an increasing determination on the part of foreign manufacturing countries not to supply their own markets with textiles, but also to become exporters. Many of these goods come to England either for sale or reshipment. As yet the imports of cotton goods to this country, and the competition of foreign cottons in neutral markets do not excite the alarm of British manufacturers. In 1884 we exported cotton goods and yarns of the value of £72,736, while we imported to the value of £2,235,000. These imports consisted largely of high-priced printed calicos from France and Germany, and calico prints form an ever-increasing portion of our own exports of manufactured cottons. The designer and calico printer are becoming more important factors in the cotton industry. Yet the chemical and artistic departments of the trade are those which have been most neglected, in the training of employees employed. Although the first aniline colours, which enter so largely into the composition of dyeing and printing materials, were invented by an Englishman, Mr. Perkin, we depend mainly on Germany and other continental countries for our supply, after sending them much of the material for the production of the colours. And with regard to artistic training, the lamentable confession has to be made that nearly the whole of the high-class designs that adorn the surface of English calicos are the productions of foreign designers, or of English designers trained in foreign countries. In an age when "the design sells the cloth," it is admitted that although English cottons surpass all others in quality and cheapness, yet if they were to depend for sale upon English designs, they would speedily be superseded by the calico prints of France, Germany, and Switzerland. There are in Paris 300 designing establishments, and calico printers state that it is cheaper to buy designs in Paris than to train designers in Lancashire. In lace manufactures of Nottingham, on the contrary, the taste in design has kept pace with

improvements in machinery. The School of Art of that town has received the generous support of the manufacturers, and it is stated that, in a large measure owing to its influence, the designs for Nottingham lace, which a few years ago were nearly all French, are now nearly all produced by Nottingham designers. In the manufacture of jute there has been a great increase during the last twenty-five years. In linen the progress has been less encouraging. It was stated in evidence before the Technical Commission by the manufacturers of Belfast, that in certain of the processes of weaving, bleaching, dyeing, and printing of linen goods, they had to yield to the superiority of France and Belgium. "Even in the higher class of damasks, the Irish production was hardly holding its own, while in fancy and coloured goods, where a knowledge of design and of chemistry comes most into play, the superior attractiveness of many continental productions was placing the Belfast makers at a serious disadvantage, especially in large markets like America, where the Irish goods once enjoyed almost a monopoly." Since this evidence was given, the weaving school has been associated with the school of art in Belfast with encouraging prospects.

In the worsted and woollen industries of the United Kingdom, whilst our strength lies in the important mechanical improvements which are here recorded, the same weakness in designing and dyeing is manifest as in cottons, and calls for great improvement. Worsted designs have been mainly copies and adaptations of designs that have previously appeared in silk goods. The imports of woollen and worsted goods and yarns amounted in 1884 to £1,000,000, a considerable proportion being all-wool goods from France and Germany, of great excellence and finish, to the making of which the continental manufacturers and dyers have paid more attention than the English. In the foregoing manufactures, in each of which the improvements in machinery have been undoubtedly great, it is clear that but for the neglect of certain factors, which lie to a great extent outside the factory, our progress would have been much greater. In the silk industry, however, the position of this country with regard to the older branches of pure silk is even less satisfactory. Upon the withdrawal of protection (by which such an impetus was given to all the other textiles), and the consequent admission of foreign goods free of duty, the industries of Coventry, Spitalfields, and other centres of the pure silk trade had declined. In 1883 our imports of silk manufactures amounted to £11,554,462; our exports during the same year amounted to £3,132,124, and it must be remembered that these exports included the goods and yarn manufactured from silk waste, the new industry which is rapidly becoming more important than the old. According to Mr. Wardle's report (Vol. III., Second report of the Royal Commissioners on Technical Instruction) of the nine original centres of the silk trade, Nottingham only has kept pace with France and Germany in the arts of design. He states that "Coventry has nothing to fear from the competition of any silk centres, except those of Basle and St. Etienne, and the reason she is beaten by these two places in the manufacture of ribbons is the superior technical knowledge they possess, which is chiefly shown in the wise arrangement of their machinery and the skill and artistic taste displayed in the selection of the quality of silk for certain manufactures, as also in the skilful arrangement of colours and designs. . . . The superiority of the artistic skill of France and Germany over Coventry owing to better technical education in these two countries. Manufacturers, and especially workmen, have much to learn in connection with many details of the trade, and until a regular system of technical education is established, Coventry will not be in a position successfully to compete with France and Switzerland in design and colouring."

Foreign Trade; Imports and Exports, 1885 and 1862.—A significant indication may be given of the importance of our trade in textiles by the following statistics. No record is obtainable of British manufactures retained for home consumption. The figures of our *foreign* trade only exports and imports—are given on page 116.

The statistics of our imports call for remark almost more than those of our exports, for they indicate the weak points in our industrial position. Our textile trades cannot be considered satisfactory while we import foreign goods, yarns and clothing of the value of £25,000,000, the only reason being that they are preferred to those of British manufacture, either because of their cheapness or attractiveness. In all instances the raw materials composing the goods are cheaper here as in the countries where the fabrics are produced, and our machinery is the best in the world. The question of cheaper labour abroad is alleged as accounting for the admission of these foreign manufactures. If it were labour only it would apply most to cotton goods, and

least to silk goods, because the wages of English cotton operatives are very much higher than those paid to their continental rivals, and form a larger proportion of the cost of the product, while in silk the wages paid in England more nearly approximate to those of the continent than in any other textile. On the other hand, the imports of silk manufactures represent more than four times the value of the imported cotton goods. The evidence of the Technical Commissioners

	1883		1882	
	IMPORTS.	EXPORTS.	IMPORTS.	EXPORTS.
	£	£	£	£
COTTON YARN	436,835	13,509,732	126,059	6,202,240
Manufactured pieces, white or plain	520,897	34,151,733	899,738	16,216,399
Printed and dyed	—	20,831,161	—	—
Mixed materials	1,819,567	551,672	—	12,346,067
Lace and Patent Net	690,925	2,709,694	93,282	518,760
Embroidery and Needlework	111,774	—	55,182	—
Stockings and Socks	—	536,315	—	282,804
Thread for sewing	—	2,361,118	—	628,942
Hosiery and small wares	—	1,162,680	—	556,269
	3,579,998	75,812,105	1,174,261	36,750,971
Goats' Hair manufactured	130,526	—	397,454	—
JUTE YARN	48,424	268,875	—	96,152
Manufactures	—	2,501,590	—	133,149
	48,424	2,770,465	—	229,301
LINEN YARN	278,574	1,057,912	—	1,852,451
Piece goods, white or plain	343,709	4,408,454	140,784	3,929,762
Checked, printed and dyed	—	213,616	—	200,665
Sailcloth, &c.	—	171,933	—	258,078
Thread for sewing	—	293,484	—	429,034
Unenumerated	—	352,082	—	316,397
	622,283	6,497,481	140,784	6,986,387
SILK THROWN	303,919	—	100,249	747,668
Twist and Yarn	—	705,825	—	348,785
Manufactures	11,554,462	1,254,603	6,618,501	798,366
Other sorts	—	1,171,696	—	466,708
	11,858,381	3,132,124	6,718,750	2,360,527
WOOLLEN YARN AND WORSTED ...	2,004,231	3,266,488	514,714	3,852,998
Manufactures	6,251,281	—	1,574,281	4,425,122
Cloths, Coatings, &c.	—	9,273,648	—	—
Worsted Coatings, &c.	—	5,765,669	—	5,581,789
Blankets	—	488,589	—	1,388,592
Flannels	—	349,235	—	—
Carpets	—	1,268,892	—	671,215
Other sorts	—	1,179,542	—	781,713
	8,255,512	21,582,063	2,088,995	16,701,429
SUNDRIES—				
APPAREL AND SLOPS	—	3,633,804	—	2,558,492
CORDAGE AND TWINE	548,674	435,594	113,996	312,988
PLATTING OF ALL SORTS	—	—	118,877	—
FELT HATS, &c.	120,405	—	—	—
BAGS AND EMPTY SACKS	—	1,137,682	—	388,724
HABERDASHERY AND MILLINERY	—	3,879,768	—	3,573,622
HATS OF ALL SORTS	—	1,137,085	—	406,062
OIL AND FLOORCLOTH	—	597,990	9,387	—
	669,079	10,821,923	242,260	7,239,883
	IMPORTS.	EXPORTS.	IMPORTS.	EXPORTS.
GRAND TOTAL OF TEXTILES ...	25,164,203	120,616,161	10,762,504	70,268,503

obtained during their visits to the competing industries of the Continent and England was undeniable upon one important matter, viz., that in those industries in which English manufacturers are surpassed by their foreign rivals, it is not so much by the lower wages paid to their operatives as by the general superiority in taste, and the scientific and chemical knowledge applied to the manufacture of the goods themselves. It would appear that this superiority is due not to the natural talent or hereditary faculties of our rivals, but rather to the facilities which they enjoy for scientific and artistic instruction of a high order. Our industrial rivals many years ago established technical schools and colleges in order that they might *overtake* the practical experience of English manufacturers. The results are brought before us in the exports of our rivals to neutral markets, and in the above statistics of our imports, which demonstrate the necessity of schools in England for training our designers, dyers, and all classes of masters and workmen in the principles of science and art underlying their industries. It is true that important steps are being taken in this direction. In several of the manufacturing centres of the country technical schools and colleges have been established and equipped with teaching appliances and machinery. The resources of some of the wealthy City Companies—particularly the Clothworkers—have been freely dispensed for the promotion of the textile arts, while the City and Guilds of London Institute is giving powerful aid in the promotion of technical instruction. It is also satisfactory to find that the department of Science and Art at South Kensington is fully alive to the needs of the country, and through its network of schools of art and science classes is supplying admirable tuition to great numbers of artisans throughout the United Kingdom. In no country in the world is there an organisation of the same character so complete and far reaching.* But the whole system of industrial education requires improvement and extension, and to do this the nation generally needs to be awakened to the importance of the improved scientific and artistic training of manufacturers and operatives upon whom, as skilled workers, depends our future commercial success. It is computed that of the population of the world, estimated at 1,400,000,000, there yet remain nearly 1,000,000,000 who do not apply machinery to the arts of life, and who are still clad in hand-made fabrics, so far as they are clothed at all. The steamship and the railway are daily bringing these vast populations more and more within the influence of Western civilization and modern wants, thus opening up new resources of wealth to the industrious and enterprising in the mutual exchange of commodities.

In the past the United Kingdom has given birth to the greatest inventors, and has been foremost in supplying the world with the products of mechanical industry. By the exercise of the same powers, by learning from competitors everything that they can teach, and by improving and developing not only our machines but the faculties of the operatives who make and mind them, we may look forward to the maintenance of our industrial supremacy in the future, and to the increased material prosperity of our country.

Keighley, March 30th, 1885.

* Whilst this preface was being written, Mr. Mundella has by the New Code introduced elementary, and more especially linear drawing from copies, and from models, as a class subject into the Elementary Schools. The influence of this step on the technical education of our artisans will prove to be of an importance the extent of which it is impossible to overrate.

ANDERSON, ANDERSON, & ANDERSON,

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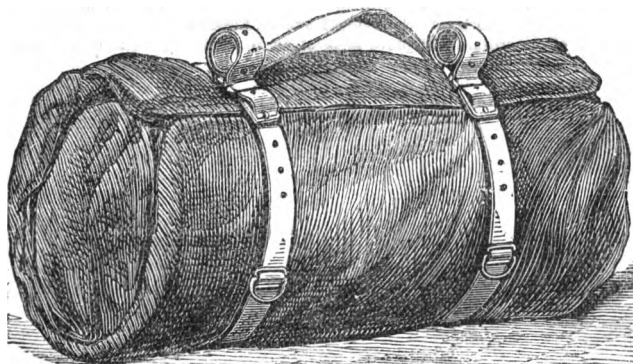
ARMY REGULATION WATERPROOF CLOAK,



AND THE

REGULATION WATERPROOF VALISE,

AS RECOMMENDED BY LORD WOLSELEY.



[COPY.]
GENERAL ORDER.—The Waterproof Coat made by you has been approved of as a pattern for the use of the Army, and is to be made in accordance with the pattern submitted, and is to be made in accordance with the pattern submitted. Your pattern has been now sealed and deposited at the Horse Guards,—I am, Gentlemen, Yours obediently, ARTHUR HERBERT, A.A.G., Col.
N.B.—A General Order on the subject will be issued in next month's orders.

G. O. 23. OFFICERS' DRESS.
A Waterproof Cloak has been approved of for Officers on duty in wet weather. The pattern has been sealed and deposited at the Horse Guards. It is optional with Officers to provide themselves with this Cloak; but no other Waterproof Overcoat is to be worn on duty.

[COPY.]
HORSE GUARDS,
12th June, 1871.

MESSES. ANDERSON, ABBOTT, & ANDERSON,—The valise made by your firm has been found well suited for the conditions proposed, viz., to enable an officer to carry the articles absolutely required for service; and the waterproof sheet answers as a bed; the whole, fittings included, not exceeding 40 lbs. weight. The pattern has been deposited at the Horse Guards for inspection.

ARTHUR HERBERT,
A.A.G., Col.

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GROUP IX.—MANUFACTURE OF TEXTILE FABRICS.

Nos. 1061—1089, WEST GALLERY.

[For Dyes, Mordants, etc., see Group XIV.]

1061. BELL, JOHN, & SON, 118 Southwark Street, London, S.E.—The Art of Spinning Asbestos Fibre by itself, without the admixture of other fibres.

1062. BUTTERWORTH & DICKINSON, Burnley, Lancashire.—Improvements in Looms for weaving, and Patent Dobby.

1063. THORPE, THOMAS, Beech Avenue, New Basford, Nottingham.—(1) Doubling Machine, with upright spindles and stop motion, for running two or more threads together [without twisting] on to spools or bobbins. Specially designed for hosiery yarns. (2) Winding Machine, with upright spindles and damping apparatus for winding from hank on to spools or bobbins. Specially designed for hosiery yarns.

1064. DAUGHTERS, GEORGE, 363 Hope Place, St. James' Road, Old Kent Road, London, S.E.—Patent Double-action Hair Carder, for carding curled hair and fibre, also old hair without breaking; can be adapted for either steam or hand power.

1065. WATSON, LAIDLAW, & CO., 23 Dundas Street, Kingston, Glasgow.—(1) Self-balancing Centrifugal Machine and Hydro Extractor [Weston's Patent]. (2) Self-balancing Electro Centrifugal Machine and Hydro Extractor [Watts' Patent]. (3) Steaming Apparatus for bleaching sugars and other granular substances [Laidlaw's Patent]. (4) Self-oiling Bearings, Self-oiling Idler Pulleys, Friction Driving Pulleys [Weston's Patent]. (5) Patent Oil Separator.

1066. LAWSON, SAMUEL, & SONS, Rope Foundry, Leeds.—Goods' Patent Automatic Spinner for rope yarns.

1067. FAWCETT, W. L., 11 Church Street, Kidderminster.—Improvements in weaving designs for, and in the manufacture of carpets and similar fabrics.

1068. FARMER, JAMES, & SONS, Adelphi Street Iron Works, Salford, Manchester.—(1) Improved Creasing and Measuring Machine, with Patent Marker to stamp the margin of the cloth with figures representing number of yards. (2) Universal Calendar, upon which the following finishes can be produced:—chasing, frictioning or creasing, swizzling, embossing, and Moiré lustre. (3) Apparatus for bleaching, washing, chloring, scouring, soaping, dunging and dyeing woven fabrics; and improvements in the same. (4) Model, showing improvements in the arrange-

ment and construction of machinery for treating town refuse, and reducing the excrementitious matter to a valuable manure; also applicable for drying and pulverizing blood and other offal.

1069. TAYLOR & SONS, Marsden, Yorkshire.—Improvements in mechanism for actuating the heads of looms for weaving, an improved joint for head levers, and also mechanism for actuating the rising and falling of boxes of looms.

1070. FAWCETT, HENRY, Kidderminster.—Chlidema Carpets. Shades of worsted combined in manufacture to produce new effects. Made to any size without mitre, cross join or false shading.

1071. MATHER & PLATT, Salford Iron Works, Manchester.—(1) Mather & Platt's Patent Sampling Machine, for calico printers, to make combinations of designs and colours on short lengths of cloths to show effects. (2) Mather's Patent Continuous Bleaching Machine, for use in the Thompson bleaching process, to supersede the chloring operation as hitherto used in bleaching. For cloth in full breadth equally as in the rope state. (3) Mather & Platt's Patent Open Soaping and Washing Machine, for cleansing printed cloth from the gums and thickening used in printing colours on cloth.

1072. TRELOAR & SONS, 68, 69 & 70 Ludgate Hill, London, E.C.—Machine for making coir plait used to make door-mats.

1073. SUTLEFF, ROBERT W., 46 Queen Victoria Street, London, E.C.—Jacquard Loom Reader.

1074. VINCENT, AUGUSTE Chateaubriant (Loire - Inférieure), France (Agent, L. E. LUZEAU-COUDRAIS, 53 Malrose Gardens, West Kensington Park, London, W.).—Finishing Machine for any kind of textile fabrics.

1075. HELYNAR, THOMAS, West Street, Bridport, Dorset.—(1) Spooler or Winder for spooling or winding cotton for fish net making machines, or for any other purpose that twine or cotton is used for. (2) Telescope Cork-Cutter for cutting circular corks for fish net buoys.

1076. LIVESLY, HENRY, Limited, Greenbank Iron Works, Blackburn.—(1) Loom for loose reed weaving shirtings with a number of improvements and patents taking up roller. (2) Old Loom, made half a century ago, to show contrast.

1077. ETCHELLS, JOHN, Silk Manufacturer, Peel Street, Macclesfield.—(1) Davenport & Crossley's Cross Border Jacquard in motion, requires no changing of cards in weaving handkerchiefs, mufflers, or striped goods. (2) An assortment of goods made on the loom.

1078. BROADBENT, ROBERT, & SON, Phoenix Iron Works, Stalybridge.

—(1) Warburton and Broadbent's Patent Conical Drum Winding Machine, for winding yarn on paper tubes. (2) Leigh's Patent Loose Boss Top Rollers for cotton machinery. (3) Instantaneous Grip Belt Fastener, dispensing with the necessity of holes in the belts, and effecting a saving of time and labour, and smoothness and regularity in driving.

1079. HODGSON, GEORGE, Thornorton Road, Bradford, Yorkshire.—Power Looms, and improvement therein.

1080. HAACKE, A. & CO., 21 Lime Street, London, E.C.; also at Celle, Brussels, Liverpool, & New York.

—(1) Braiding Machine for the manufacture of non-conducting ropes filled with fossil meal. (2) Samples of Raw, Washed, Calcined and Pulverised Fossil Meal or Infusorial Earth [Kieselguhr].

1081. GLOVER, WALTER T., & CO., Salford, Manchester.—(1) James' Patent Doubling and Laying Machine for making all kinds of cords, twine, fishing lines, gold thread, asbestos, worsted, bullion fringe, silk cord, &c. (2) James' Rope-making Machine, on which ropes can be made of any length or thickness. (3) Bell's Patent Rope Pulley Friction Brake. (4) Riley's Piston Ring. (5) New Standard Wire Gauge.

1082. SHAW, PROF. HELE, University College, Bristol.—Sphere and Roller Mechanism for the transmission of power.

1083. HACKING & CO., Bury, Lancashire.—(1) Looms for weaving checks with patent 4-shuttle motion. Improved Loom for weaving trowserings. (2) Patent Machine for folding and measuring finished woven fabrics. (3) Machine for winding coloured yarn on to weavers' pirns and paper tubes.

1084. BROOKS, SAMUEL, Union Iron Works, West Gorton, Manchester.—Improvements in Drawing Frames for cotton, Ring Spinning Frames for both warp and weft yarn, Ring Doubling Frame, Winding Frame, and Reel.

1085. McNARY MACHINES CO., Limited, 69 Lombard Street, London, E.C.—Improvements in machinery for the manufacture of various fabrics, in wool, cotton, hemp, jute, &c.; also close and open fabrics of novel character, and seamless hats, caps, and bag-shaped articles.

1086. ASBESTOS CO., Limited (THE UNITED), 161 Queen Victoria Street, London, E.C.—(1) Asbestos Packing Machine, for making pure Italian asbestos gland packing with either round or square section. (2) Specimens of packing.

1087. HOWELL & JAMES, Limited, 5, 7, & 9 Regent Street, and 10 Charles Street, St. James', London, S.W.—(1)

Irish Hand Loom, with weaver at work. (2) Samples of Damask Table Linen in the different stages of manufacture. (3) Samples of Irish and Courtrai Flax, &c.

1089. GAUNTLETT, C., & CO., Union Factory, Trowbridge, Wilts.—(1) Lightning Carding Machine for carding, dressing, and opening woollen and cotton flecks, hair, and other fibrous materials. (2) Excelsior Carding Machine, specially made for opening hair and fibres only, by passing it between two revolving bright steel spiked cylinders with a patent delivery.

1090. ANDERSON - LAING, S. J., Slitrig House, Hawick, N.B.—Self-acting Winding Engine with self-acting oiling and damping machine combined.

Nos. 1093-1121, WEST ARCADE.

1093. KAY, T. B., Arcade Chambers, St. Mary's Gate, Manchester.—Improvements in Carding Engines, to secure a more truthful gridding and setting of travelling flats. Each flat is ground and bevelled from its sliding surfaces instead of from its back. The flats are set simultaneously to the cylinder arc by two rigid conical segments instead of by the flexible bends.

1094. RIDDELL, W. MOORE, West-hall Road, Forest Hill, London, S.E.—Improved Wool Extract, Buried Wool, Bleached Wool, and Wool Waste for Manure.

1096. NELSON, A. H., Sherland Works, Station Road, Twickenham, London, S.W.—Patent Collentum Flooring Cloth.

1098. FAWCETT, F. B., Kidderminster.—Brussels Velvet Carpets and Rugs, with combination of colours producing new tints.

1100. BALDWIN, HENRY, & CO., 29 Great St. Helens, London, E.C.—Sapo, a substitute for soap for scouring, fulling, pizing, and finishing woollen goods.

1101. SACHS' ENGRAVING CO., Limited (THE), 8 Union Court, Old Broad Street, London, E.C.—New Processes for engraving, printing and embossing, surfaces suitable for calico printing and for printing other textile fabrics, also paper-hangings, wall decorations and book illustration.

1102. YOUNGSON, ALEXANDER, 3 Chesnut Row, Belmont, Aberdeen.—An Improved Drag Arrangement for spinning machines.

1103. ARNOLD; ALFRED, Clare Hall, Halifax.—Improvements in Wire-woven Fabrics.

1104. WHITTALL, M., & CO., Kidderminster.—Improvements in the manufacture of embossed fabrics or fabrics having portions of the surface raised or in relief.

1106. **MIDWOOD, ALFRED H., & CO.**, 81 Fountain Street, Manchester.—(1) Lyceum Satteen Cloth. (2) Unique Specimens of Portrait Printing on Calico for costumes, aprons, &c.; also novelties for dress linings.

1108. **TURNER, M. A., & CO.**, 14 Bladhow Terrace, South Kensington, London, S.W.—(1) New Patent Tambour Frame for lace-workers and embroiderers. (2) Lacemaking and Embroidering on the Frames daily from 11 a.m. to 7 p.m. (3) The New Unnaught Fingering Wools, with knitted specimens.

1110. **FLEMING, ALBERT**, Neaumrag, Langdale, Ambleside, Westmoreland.—Langdale Linen, showing the revival of hand-spinning and hand-weaving linen in Westmoreland.

1112. **DICKINSON, W., & SONS**, Conmix Iron Works, Blackburn.—(1) Sewing Presser. (2) Handkerchief Motion for sewing handkerchiefs. (3) Tension Motion for the winding on of yarn.

1113. **KING, JOHN**, Chepstow Street, Manchester.—Improvements in the twisting or doubling of yarn or other fibrous threads.

1114. **TWEEDALE, THOMAS**, Sunnydale, Rawtenstall, Lancashire.—Improvements in Shuttles.

1116. **WILSON BROTHERS**, Cornholme Mills, Todmorden.—Improvements in the manufacture and for the strengthening and protecting of wood bobbins, tubes, spools, &c., used in textile machinery.

1117. **HARDING, T. R., & SON**, Power Works, Leeds.—(1) Cast Steel Gill and Card Pins ground on Harding's Patent Machine. (2) Patent Machine-drilled Needle Combs, Porcupines and Gills.

1118. **WORTH, ALBERT R.**, Francis Street Mill, Rochdale.—Tubular Spindle and Cotton Washer Cloths.

1119. **BURGESS, W. J. & C. T.**, Victoria Works, Brentwood, Essex; and Aborn Viaduct, London, E.C.—Emery Saw Cotton Gin, with Burgess's new patent Squeezer, fitted to be worked by hand, suitable for all kinds of cotton. Fitted with thorn-shaped saws and grids.

1120. **DRONSFIELD BROTHERS**, Atlas Works, Oldham.—(1) Patent Card-setting Machine. (2) Model of patent motion for setting card rollers. (3) Card-grinding Rollers with patent grooved covering. (4) Patent Emery Wheel Grinders. (5) Patent Filleting Machine for roller leathers. (6) Roller-grinding Machine with patent steps. (7) Machine for Drawing Leathers on Rollers. (8) Samples of Patent Emery filleting.

1121. **PARRY & ROCKE**, Swansea.—Welsh Knitting Yarns and Welsh Hand-knitted Hosiery.

ARUNDEL & CO., Bromley Street Works, Ashley Lane, Manchester. (See Group IV.)

ASBESTOS CO., Limited (THE UNITED), 161 Queen Victoria Street, London, E.C. (See Group IV.)

BARLOW, H. B., JUN., & CO., Cornbrook Works, Manchester. (See Group X.)

BRITISH ALIZARINE CO., Limited (THE), 64 Cannon Street, E.C.; and Silvertown, London, E. (See Group XIV.)

BURT, BOULTON, & HAYWOOD, 64 Cannon Street, London, E.C. (See Group XIV.)

COKE, ARTHUR, 339 Oxford Street, London, W. (See Group XXII.)

CROSSLEY, C. W., 14 St. Mary Axe, London, E.C. (See Group II.)

GREIG, J., & CO., Regent Works, Regent Road, Edinburgh. (See Group XVII.)

HONYWOOD, THOMAS, Courtenay House, The Causeway, Horsham. (See Group XXVI.)

KIRKALDY, JOHN, 40 West India Dock Road, London, E. (See Group IV.)

MIDFORD FULLER'S EARTH WORKS, Limited (THE), Bath. (See Group II.)

PATENT LIQUID FIRE-PROOF CYANITE PAINT CO., Limited (THE), 82 Bishopsgate Street Within, E.C.; and Gunter Grove Works, Chelsea, London, S.W. (See Group XIV.)

RICHTER PATENT ECONOMISER MANUFACTURING CO. (THE), West End Mills, Longside Lane, Bradford. (See Group IV.)

SLATE DEBRIS UTILIZATION CO. (THE), 5 Westminster Chambers, Victoria Street, London, S.W. (See Group III.)

SMITH, S., & SONS, Gosford Brass Works, Nottingham. (See Group IV.)

SPENCER, JOHN, & CO., Atlas Works, Keighley, Yorkshire. (See Group X.)

SWAN, J. W., Bromley, Kent. (See Group XIII.)

WILSON, J., VEITCH, & CO., 260 Dobbies Loan, Glasgow. (See Group XIV.)

HOLDEN & BROOKE, SALFORD, MANCHESTER.

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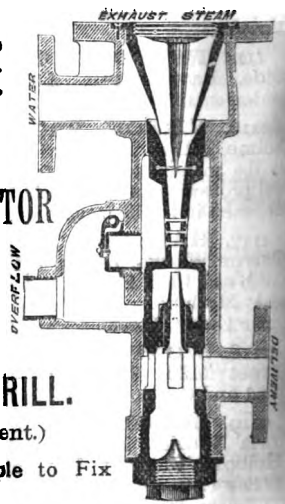
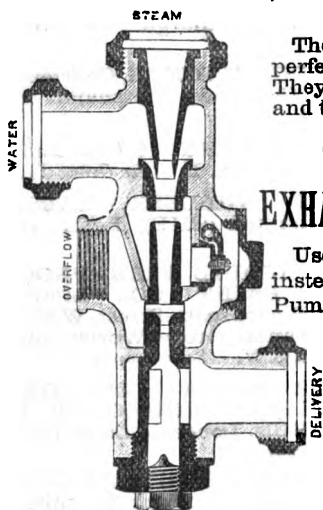
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MACHINE TOOLS AND MACHINERY.

By W. C. UNWIN, B.Sc.

The machinery of an engineering factory consists of a Prime Mover, which affords the necessary supply of energy; Transmissive Machinery, which distributes the energy to convenient points and delivers it at suitable speeds; and Machine Tools, which perform the various operations of the workshop. The term machine tools is generally restricted to those machines which are used to shape iron, wood, or stone for constructive purposes. Modern machine tools originated in the lathes and other contrivances used by the clockmakers, small arms manufacturers, and makers of Ordnance in the last century; but the earliest straight-line planing machine was used by Clement in 1819, and the first slotting machine by Fairbairn and Lillie in 1828. With the advent of the steam engine came the need of doing by machinery, on the large scale, all the operations previously carried out, laboriously, on a small scale by hand, and the rapid development of engineering has been rendered possible by the rapid invention of machine tools, the enormous increase of their speed and power, and the perfection and accuracy attained in their manufacture, during a period extending over much more than half a century. What the advance has been may be judged by examining, say, a modern milling machine, with its indexes graduated to $\frac{1}{1000}$ th of an inch, and by thinking of this sentence in a letter from Watt to Smeaton: "Mr. Wilkinson has improved the boring cylinders, so that I promise upon a 72-inch cylinder being not further from the truth than the thickness of a thin sixpence in the worst part."

MACHINE TOOLS FOR METALS.

Machine tools for shaping metal fall for the most part into the following groups:—

1. Compressing machines, such as steam hammers, power hammers, riveters, forging presses.
2. Abrading machines, including grindstones, emery wheels, polishing machines, and the less perfectly formed rose cutters and milling cutters.
3. Shearing machines, such as ordinary plate shears, and punching machines, in which the material gives way over a large area simultaneously in the plane in which the cutting edges produce a tangential stress.

4. Cutting machines, in which a properly formed cutting tool removes the material stroke by stroke, or by a continuous spiral cut, over a surface of the required form.

Most of the machine tools at present in use were invented, and in many cases very perfectly constructed, before 1862. In reviewing the progress made in the last twenty-five years, therefore, we have to do rather with changes and improvements of detail, than with completely novel machines. But these changes and improvements are many of them of great importance. The so-called "interchangeable system" of manufacture has made great progress. In this a group of machine tools are arranged to produce the several pieces of a finished machine, so exact in size and form, that they can be used interchangeably in building up the machine. By specialising the machine tools in this way the work is far more perfectly and rapidly accomplished, and the tedious and expensive process of fitting by hand is entirely abolished.

Machines of Compression.—The steam hammer has been much improved and simplified in the last twenty-five years, and increased in size and power. In the earlier hammers the blow was entirely to the weight of the tup or hammer block descending the height of the stroke. In the modern hammers now the steam acts on the top of the piston, in the working stroke, as well as on the under side in lifting the hammer. This plan, introduced by Naylor, greatly increases the energy of the blow. Hydraulic forging was first carried out successfully on a large scale by Mr. Schindler in Vienna. The wrought iron is brought to welding heat and compressed in moulds or by hydraulic presses, under a pressure of 800 to 1500 tons. Comparatively intricate forms, such as crossheads, pistons, axle-boxes, &c., are made in this way more accurately than by ordinary forging, and, when a large number are required of one shape and size, at little cost.

Amongst machine tools of this class, almost entirely belonging to the period to which the Exhibition relates, are the smaller forging hammers and planishing hammers, worked by power, which are now extensively adopted. Ryder's forging machine was introduced about twenty-five years ago. It has a series of very rapidly reciprocating hammers driven by eccentrics. These hammers swage or dies, and by bringing a bar successively under these dies, it is very rapidly reduced

to the required form. Rivet-making and bolt-making machines act on the same principle. More recently drop hammers have been introduced. A pair of friction rollers, driven by belting, grip a plank or wooden bar attached to the hammer-head, and lift it. By releasing the friction rollers automatically or by hand at different heights, blows of greater or less energy are given. The wooden rod is attached to the hammer by an elastic connection to prevent the jar in first starting it into motion. Dies are used on the hammer and anvil, so that forgings of complicated form and exact dimensions are produced. The drop press is very useful in making the parts of small arm sewing machines and other articles, in which large numbers of similar small forgings are required. In the pneumatic hammer of Longworth and Player, the hammer at the end of a rocking lever is driven by a crank at the other end, the action being similar to that in hand hammering. To vary the stroke of the hammer and the force of the blow, the fulcrum of the lever can be moved to wards or away from the crank. To enable the hammer to adapt itself to the varying thickness of the work, there is an air cushion between the hammer-head and the lever. In the pneumatic power hammer the rate of striking is constant, whether the blow is light or heavy.

MACHINES OF ABRASION.

An extremely important improvement has been the introduction of solid emery wheels to replace the grindstones and to some extent the filing processes previously in use. Emery wheels are artificially made blocks of uniform texture and hardness, with which grinding processes can be carried out with very great accuracy. They are easily moulded to any required shape of edge or surface, and can be trued up when worn by a diamond tool. They are run fast, at about 3000 to 6000 feet of surface speed per minute. They are used in many ways. Thus they replace natural grindstones as tool grinders, cutting faster and giving a better edge to the tool, and at the same time requiring far less truing up. Used dry, as bench grinders, they replace to a great extent the file. Mounted with suitable tables for the work, they may be used as planing or shaping machines, in producing true plane surfaces. As they cut hardened steel or case-hardened iron, they are used in grinding lathe mandrills and shaping calendar rolls, or in grooving tape and rymers. Specially arranged machines with emery wheels are used for regrinding milling cutters and twist drills; in both cases the proper cutting edges are reproduced with perfect exactness, almost automatic arrangements and without softening the steel.

Another new process of abrasion may be mentioned here, namely the Sand Blast or Tilghman. A jet of air loaded with particles of sand is able at sufficient velocity of impact to cut materials much harder than the sand itself. The practical applications of the sand blast are probably not yet fully developed. It is used for etching patterns on glass, for sharpening files, fettling castings and boring holes in hard substances.

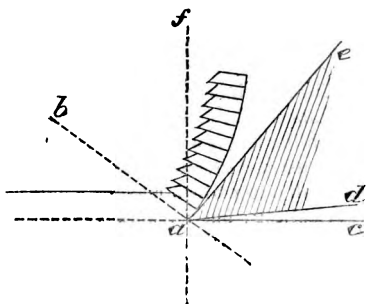
CUTTING MACHINE TOOLS.

The principal machine tools for cutting metals have undergone little change of form or principle in recent times. The lathe, the planing machine, the shaping machine, the slotting machine, and the drilling machine were all in use and tolerably perfect twenty-five years ago. The greatest change in these, the introduction of scraped surfaces and rigid hollow framing, Sir J. Whitworth, dates back about thirty-five years. Still in the specialisation of these tools to particular purposes, and in the much more extensive use of rotating cutters, a considerable progress has been made.

In any machine tool of this kind there are (1) arrangements for holding the cutting tool and presenting it at the right angle to the work; (2) arrangements for conveniently fixing the work; (3) mechanism connecting the tool and the work so as to secure the proper relative motion. Generally three motions are required: the motion which produces the cutting stroke, either the tool or the work moving as is most convenient; a feed motion at right angles to the cutting stroke, continuous or intermittent—usually if the cutting stroke is made by the motion of the work the feed motion is given to the tool, and *vice versa*; lastly, a motion is required at right angles to the other two to advance the tool into cut.

The Action of a Cutting Tool.—The action of cutting tools has been investigated by H. Thime, Tresca and Judenfeind Hulsse on the Continent, and by Mallock and Smith in this country. In some cases, as in wood-cutting tools, a shaving is split off, by a very acute cutting tool, which is very little deformed in the operation, and this action is facilitated by the very low tenacity of the wood in certain directions. In cutting metals the action is different. The shaving

removed is $\frac{1}{2}$ to $\frac{3}{4}$ shorter than the cut surface from which it is taken, and if examined will be found to consist of a series of strips, which have successively sheared, in planes oblique to the cut surface. Let $d a e$ represent the tool edge in a plane passing through the normal $a f$ to the cut surface and the direction of cutting $c a$. Then without going into theoretical details, the following points are recognised as practically important. (1) The back of the tool $a d$ must recede from the work by an angle $c a d$ of 3° to 6° , called the angle of relief. This prevents the tool being forced out of cut and diminishes the friction on the tool. (2) The angle $d a e$ of the cutting tool is called the cutting angle. If this is too small for any given material the tool edge breaks, or is rapidly blunted, and time is lost in regrinding it. There is also a value of $d a e$ for any material which makes the pressure required to drive the tool least. In practice a compromise is effected, the angle



$d a e$ being made somewhat larger than that which makes the work of cutting least, in order to secure greater durability for the tool. In all strictly cutting tools the angle $c a e$ is acute. But they are also used for light cuts, in which $c a e$ is obtuse, and these are termed scraping tools. They leave a better surface on the work than cutting tools. (3) There is a limiting velocity which depends on the material and mode of cutting, which must not be exceeded, or the heat generated at the tool point will spoil the temper of the tool. The velocity of cutting is higher the more perfectly the tool angles are adjusted to the work to be done. Hence, it is of very great importance to grind tools exactly to proper angles, and to present them to the work in the proper position, in order that as much work as possible may be got out of the expensive machine tools and that the workman's time may not be wasted. One of the improvements of late years has been the introduction of special machines for holding the tools, when being ground, in the exact position which secures their being ground to the intended angles. In the case of twist drills, reaming cutters, and some other cases, the cost of such special grinding tools is amply repaid by the extra amount of work done.

Improvements in Machine Tools for Cutting Metals.—The lathe is the oldest and still the most universal of machine tools. It has been improved by substituting cut gearing for cast gearing. American makers have introduced a new form of bed in which the saddle slides on inverted V's and is steadied by a weight. Capstan or turret lathes are used. The capstan is a form of revolving tool holder attached to the saddle and capable of carrying several tools. Each of these can be brought into use successively. When a number of pieces of the same form are required, they can be finished off in succession, without the waste of time involved in changing and setting the tools in the slide rest. For screwing bolts of different sizes, a series of dies may be fixed in the capstan. Hollow mandrils, permitting a rod to be introduced from the back of the headstock, are convenient, pins or bolts being turned and cut off in succession, the rod being fixed without trouble in a self-centering chuck. For lathes, the many ingenious forms of self-centering chucks, which are manufactured chiefly in America, are very convenient.

In the Planing Machine the most interesting alteration has been in the mode of moving the work. Messrs. Sellers use a worm on an inclined shaft, acting on a rack under the table. This gives a very smooth motion with very simple and durable mechanism. Very large planing machines, in which the work is fixed and the tool traverses, being driven by two parallel screws for the horizontal cut, and a single screw for the vertical cut, are now made for planing marine engine beds and other very heavy pieces. In slotting machines, the slide is now often balanced and a quick return motion applied. Slotting machines with the gear below the table, for key cutting, have also been used. Combined slotting and planing machines have also been made, the work moving and the feed applied to the tool in horizontal cutting, and the tool moving and the feed applied to the work in vertical cutting.

In drilling machinery there is an advance in the direction of using multiple drills, especially for drilling holes in the thick steel plates now used for boilers and girders. Radial drills have been generally introduced. Traversing drills for cutting cotter holes and slots are also used

In Shanks's duplex slot drill the slot is drilled from both sides, so that the drills are shorter and stiffer. Twist drills, first brought into general use in America, are replacing ordinary drills. The twist drill presents its cutting edge to the work in exactly the best position, and, with proper appliances, is reground when blunted with the greatest accuracy and the least trouble. The economical production of twist drills is a result of the introduction of the emery wheel and milling machine.

MILLING MACHINES.

The most important change in mechanical processes which has occurred in the last twenty-five years has been the very general introduction of milling, in place of planing and shaping. The milling tool is a revolving cutter with numerous cutting edges. As each of these edges cut in succession, a greater amount of work can be done, so long as the depth of cut is not too great than with a tool which makes a single cut per stroke. The milling cutter is not adapted for very heavy cutting; but for work within the range of its powers, especially for finishing processes on curved and twisted surfaces, it is far more convenient and rapid than the older processes. The success of the milling tool depends on the accurate formation of its cutting edges. If all these are not equally in cut, it works very imperfectly. Till recently, though a well-known tool, it was little used, simply because it was impossible to form its cutting edges accurately enough at moderate cost by filing and retempering. Since the introduction of small emery wheels this difficulty has been completely removed. A small special emery grinding machine is made, which reshapes the milling cutter with perfect accuracy and without softening and retempering. The cutters are of a variety of forms. Face-milling cutters have cutting edges on one surface and on the circumferential edge of the disc. Cylindrical milling cutters have spiral cutting edges on their cylindrical surface. Conical, angular and curved section cutters are also made. Special sets of cutters are made for milling out the teeth of toothed wheels from cast or forged blanks. The cutting speed is much greater than in ordinary metal cutting. Thus speeds of 80 to 100 feet per minute are used for wrought iron, and 25 to 30 feet for cast steel. Messrs. Smith & Coventry have introduced a form of milling cutter which requires grinding on one face only of each tooth.

Profiling machines are edge-milling machines, in which the tool, revolving horizontally on a vertical spindle, is guided by a templet. Any number of pieces can thus be produced of accurately the same form.

Milling machines lend themselves conveniently to the "interchangeable" system of manufacture already referred to.

Milling cutters, consisting of a slotted head with separate cutters inserted, have long been used in facing hexagon nuts, and for other similar purposes. A very useful machine of this kind has been introduced by Messrs. Buckton, for cutting the indentations in the sides of plate specimens for the testing machine. The pieces of plate are traversed between two revolving cutter heads which at once reduce the middle part to the exact width required.

CUTTER HOLDERS.

One very great improvement which belongs entirely to the last twenty-five years is the introduction, in ordinary engineering practice, of tool-holders. Instead of forging a bar into a point, round nosed, cranked or other form of tool, a tool-holder may be used in which a short piece of steel can be fixed in such a position that it forms a suitable tool without any forging, and with much less grinding than in the case of ordinary bar tools. The first generally used form of these tool-holders was one for holding a short piece of round steel, so placed that, when its top surface only was ground to a proper slope, it had the proper cutting angles. These tool-holders of Messrs. Smith & Coventry are still the most suitable for roughing out; but they do not meet all the conditions required in shaping square, bevel and undercut surfaces. Messrs. Smith & Coventry have since introduced a swivel cutter-holder, which takes a short piece of steel, of deep wedge-shaped section, and one or two special tool-holders also, with the aid of which every operation of the lathe, planing, shaping and slotting machine can be performed, and which completely supersede the necessity for forging tools. In all cases the cutter for the cutter-holder is ground on one surface only, while a forged tool must be ground on several surfaces. It is easy, therefore, with cutter-holders to adopt a system of grinding, with a slide-rest on the grindstone, which ensures the desired angle being obtained. Messrs. Tangey and other makers have also introduced cutter-holders. It should be noted, however, that engineers are not quite agreed as to the advantages of cutter-holders. For very heavy cutting, at all events, the solid tool appears best.

MISCELLANEOUS MACHINE TOOLS.

Amongst engineers' tools the wheel-moulding machine, introduced about 1855 by Messrs. Jackson, should be mentioned, and a similar machine since invented by Mr. O. L. Scott. These machines supersede the necessity of making wood patterns of gearing, and the wheels thus moulded are more accurate than pattern-moulded wheels. Further, some forms of wheels, such as those with helical teeth, can be cast, which could not be moulded from a pattern.

WOOD-WORKING MACHINES.

In wood-working machines the problems to be dealt with are more difficult than in metal-working, and hence wood-working machines have been more recently introduced, and probably are not yet reached their full application. Metals differ not widely in hardness, and the forms required are for the most part simple. Woods are of much greater variety of hardness and texture, and their properties vary according to the direction in which they are cut. The cutting angles of the tools must be varied according to the work to be done, and the cutting speed ranges from 100 to 8000 feet per minute. This high speed of wood-working tools involves peculiarities of construction, balancing, and lubrication.

Saving Machines.—There are heavy circular saws for "breaking" logs; frame saws for cutting logs into planks; circular saws for sawing to dimension; and band saws for curved work.

Circular saws for breaking logs are large, with a feed of 1 to 3 inches per revolution. In these saws, which are reciprocating, the feed is intermittent. The feed is given either by a rack on the table or by rollers grasping the log. Dimension saws are about 4 feet diameter, with a speed at periphery of 10,000 feet per minute, and a feed of $\frac{1}{4}$ inch per revolution. The table is provided with moveable fences for guiding the timber. There are usually two saws—one for cutting, and one for cross-cutting, either of which can be brought above the table at will. The cutters are concave at the sides, to give an angle of relief to the saw teeth. Band saws are extremely useful for miscellaneous work, as in pattern-making. The only defect has been the liability of the saw to break. This is diminished by supporting the top pulley on a weighted lever to ensure uniformity of tension. In starting and stopping the saw, however, the inertia of the top pulley tends to break the saw. Mr. Richards has introduced a very light top pulley, made like a bicycle wheel.

Planing Machines.—Most of these have revolving cutters, under or over which the timber is reversed. The dimension planer smooths one surface only. The four-sided planer, useful where great quantity of wood is to be reduced to one size, smooths all four surfaces at one operation; it has four cutter blocks. The scraping machine is a planer with a single fixed cutter, which removes an extremely thin shaving. Scraping by machine instead of by hand was first accomplished by B. D. Whitney. The cutter is very accurately ground by special machinery, its edge projecting only $\frac{1}{1000}$ th inch above the block. It removes a single wide thin shaving and leaves a perfect surface. Straight mouldings can be cut with the four-sided planer, but special machines are also made for cutting curved mouldings. Boring machines have vertical or horizontal, and single or multiple boring bits. Mortising machines are made on two principles. In one the surface is cut by a chisel working vertically; in another a revolving cutter is used. Tenoning machines are made with revolving cutters. Various special machines are also used, on the principle of the copying lathe, for cutting wheel spokes and other special forms.

STONE-WORKING MACHINERY.

Great difficulties have attended the introduction of machinery for working stone, and it is recently that stone-working machines have been practically and successfully adopted on a large scale.

In Hunter's stone-cutting machine the tools are simple conical-headed pins fixed in the edge of a large rotating disc. Usually two discs are used, cutting two parallel surfaces to gauge. The stone traverses between the discs on a carriage. The Coates stone-cutting machine has sharp edged washers strung on a horizontal shaft. These annular cutters are traversed over the stone on a slide. Stone-sawing machines have been largely used in cutting Portland stone. The saw blades are set in reciprocating frames. Machines of the nature of planing machines are also used, with fixed or rotating cutters, for working straight or curved mouldings. In rubbing machines the stone is placed on a rotating plate with sand and water, and its surface ground or abraded.

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**GROUP X.—MACHINE TOOLS
AND MACHINERY.****WEST GALLERY.**

[For Steam Hammers and Forging Machinery used in iron and steel making, see Group XI.; for Machines for making Horse-shoes and Horse-nails, see also Group VI.]

1124. **RANSOME, A., & CO., Stanley Works, Chelsea, London, S.W.**—Steam Tree-felling Machinery and Wood-working Machinery generally.

1125. **DAVIS, JOHN, & SON, All Saints Works, Derby; and 118 Newgate Street, London, E.C.**—Hamilton's Patent Stand-feed Planing, Jointing and Chamfering Machine. Wood of unequal thickness transversely can be made of uniform thickness or the reverse.

1126. **DUFFY, H. C., & SON, 66 Works Road, Bermondsey, London, S.E.**—Wood Block Flooring and Wood-paving.

1127. **BRUNTON & TRIER, 19 Great George Street, Westminster, London, S.W.**—Machinery and Tools for dressing, shaping, planing, sinking, turning, and moulding stone.

1128. **POWIS & CO., Great Western Approach, Cardiff; and 59 Gracechurch Street, London, E.C.**—(1) A Machine called the Joiner Universal. (2) A Machine for the manufacture of banister rails, gun-stocks, shoe heels, &c. (3) A Model of a Steam Navy.

1129. **MARSDEN, H. R., Leeds.**—(1) Stone Breaker and Ore Crusher. (2) Pulveriser or Fine Crusher.

1130. **WORSSAM, SAMUEL, & CO., Oakley Works, King's Road, Chelsea, London, S.W.**—(1) Patent Four-Cutter General Joiner. (2) Patent Rope and Roller Band Saw Bench. (3) Patent Band Saw Sharpening Machine.

1131. **HULSE & CO., Ordsal Works, Salford, Manchester.**—(1) Patent Self-acting Gap Lathe. (2) Improved Hollow Spindle Lathe. (3) Patent Broad Traverse Planing Machine. (4) Patent Vertical Drilling and Boring Machine. (5) Patent Radial Drilling Machine. (6) Patent Horizontal Slot Drilling Machine. (7) Patent Vertical Milling Machine. (8) Improved Horizontal Milling Machine. (9) Improved Profiling Machine. (10) Improved Pipe Screwing Apparatus. (11) Patent Toolholders. (12) Surface Plates, &c., &c.

1132. **GREENWOOD & BATLEY, Albion Works, Leeds.**—(1) Machine for shaping bevel wheels. (2) Parker's Patent Automatic Screw-making Machine. (3) Hure's Patent Cutter-making Machine. (4) Saget's Patent Cutter-making Machine. (5) Improved Pentagraph Cutter-making Machine. (6) Medium Pattern Universal Milling Machine. (7) Milling Machine to cut twist drills. (8) Patent Grinding Lathe for backing twist drills. (9) Twist Drill Grinding Machine. (10) Kreutzberger's Patent Grinding Machine for milling cutters.

1133. **KINGSTON, FRANK, 9 Bolden Street, St. John's, Deptford, Kent.**—Improvements in machinery for cutting, assembling, and binding firewood.

1134. **BUMSTED, F. D., Cannock Chase Foundry and Engine Works, Hednesford.**—(1) Machinery for folding, pasting, and pressing paper bags, square bottom and plain bottom. (2) Machinery for eye-letting labels or tallies from a continuous roll of paper or glazed canvas.

1135. **BRINJES & GOODWIN, Whitechapel Engine Works, Fieldgate Street, London, E.**—Improved Machinery for mixing and grinding pigments, white lead, ink, paint, colours, zinc, white soap, chocolate-oxides, cocoa-nut, and all kinds of wet materials.

1136. **CHUBB & SONS' LOCK AND SAFE CO., Limited, 126 Queen Victoria Street, E.C.**—(1) A Slow Working Steel Saw, and a Grinding Machine, especially made for preparing the frames and bolts of Chubb's Patent Fire and Thief-resisting Steel Safes. (2) Model of Chubb's Lock and Safe Factory. (3) Model of a Chubb's Patent Steel Strong Room. (4) Safe.

1137. **ONSLow, T. T., Riga Wharf, Canal Road, Hoxton, N.**—Machine for making blocks for lighting fires.

1138. **TUSHAW, J., & CO., 132 City Road, London, E.C.**—An Improved Self-feeding and Automatic Machine or Apparatus for the purposes of punching, perforating, or indenting, and shearing or cutting plates, sheets, tee and angle irons, hoop iron, &c., &c.

1139. **SALES, POLLARD, & CO., 29 Farringdon Road, E.C.**—(1) Machine for packeting tobacco. (2) Machine for making cigarettes. (3) Machine for making cigars.

1140. **MINTONS, Limited, Stoke-upon-Trent.**—Improvements in the manufacture of pottery.

1141. **WILLETT, THOMAS, & CO., Brickhouse Street, Burslem, Staffordshire.**—(1) Patent Self-acting Combined Jigger and Jolly. (2) Patent Automatic Bat-making Machine.

1142. **NEWELL, WILLIAM, 24 to 27 Moseley Road, Birmingham.**—Embossing of Tin Ware with machinery in motion, showing process of manufacture and exhibit of finished goods.

1143. **SHANKS, THOMAS, & CO., Union Iron Works, Johnstone, Renfrewshire.**—Machinery for turning and screw-cutting.

1144. **LISTON, JOHN, 51 Hozier Street, Glasgow.**—(1) Improvements in apparatus for sizing, assorting, and branding corks. (2) Improvements in apparatus for cutting or shaping bungs, floats, &c.

1145. **HOLDEN & BROOKE, St. Simon's Works, Salford, Lancashire.**—(1) The Influx Automatic Re-starting Injector. (2) Improved Exhaust Steam Injectors. (3) Improved Non-lifting Injectors. (4) Patent Portable Boiler Drilling Machine.

1146. WATTS, JOHN, & CO., Broad Weir Works, Bristol.—Watts' Patent Double Band Saw Machine for deep cutting. Its special feature is that of taking two cuts simultaneously. Both saws are driven by one driving pulley and one belt, thereby insuring a uniform speed for each saw.

1147. HALL, J. & E., 23 St. Swithain's Lane, London, E.C.—(1) Blowers for smiths' hearths, &c. (2) Continuous Lift.

1148. ANDREW, FREDERICK, 24 Botolph Lane, Eastcheap, London, E.C.—Andrew's Patent Barrel Stave.

1149. BROADBENT, ROBERT, & SON, Phoenix Iron Works, Stalybridge, Cheshire.—(1) Patent Improved Blake Stone-breaker, fitted with all latest improvements, and Broadbent's Patent Positive Draw-back Motion, dispensing with springs and india-rubber buffers. (2) Instantaneous Grip Belt Fastener, dispensing with the necessity of holes in the belts, and effecting a saving of time and labour, and smoothness and regularity in driving.

1150. TEMPLEMAN, JAMES, 14 Vinicombe Street, Hillhead, Glasgow.—Improvements in the manufacture of firelighters and fuel blocks, and in apparatus employed therein.

1151. SPENCER, JOHN, & CO., Atlas Works, Keighley, Yorkshire.—Patent Slotting and Shaping Machine, for cutting keyways in wheels, pulleys or other articles of any diameters. A portable machine for working by hand; also arranged for working by steam-power.

1152. BELLOTTI, SALVATORE, 60 King Street, Soho, London, W.—La Polisseuse, or Painter's Machine, for rubbing, flattening and polishing marble, wood, iron, &c.

1153. HARPERS, Limited, Albion Iron Works, Aberdeen.—The Keyseater. A machine for cutting keyways in wheels, pulleys, &c., of any size.

1155. DAVISON INSKIPP & MACKENZIE, 62 Leadenhall Street, London, E.C.—(1) Patent High Pressure Steam Jacketed Coppers and other Boiling Vessels, for use in breweries, distilleries, refineries, and other trades. (2) Sectional Diagrams of Wort Copper and Mashing Liquor Tank, and illustration of use in breweries.

1156. BUTLER, SAMUEL, 127 Bute Road, Cardiff.—(1) Coal Staith. (2) Plans.

1158. RUDGE, D., & CO., Coventry.—Improvements in the manufacture of ball bearings.

1159. COVENTRY MACHINE CO., Limited, 16 Holborn Viaduct, London, E.C.—Grip Vice.

1160. SNOWDON, JOHN, Thirlwell House, Deronda Road, Heron Hill, London, S.E.—Boring, Reaming, and Screw Cutting Apparatus, for application to fixed pillar, radial arm or horizontal drilling machines.

1161. TAYLOR, CHARLES, Edmund Street, Birmingham.—(1) Patent Lathe Tool Holders, for screw cutting and general

turning and boring. (2) A Patent Parallel Machine Vice. (3) Improved Slide Rest Tool Holder, for holding the cutter bar.

1162. ALLIX & TRUDGETT, 73 Walker Street, Burdett Road, London, E.—Allix's Patent Roller Tube Expander.

1163. FAIRFAX, J. S., 3 St. Paul's Road, Camden Square, N.W.—Machine for moulding in green sand. Model and drawings, and specimen castings in iron.

1164. OLRIK, LEWIS, & CO., 29 Leadenhall Street, E.C.—Patent Differential Self-feeding Ratchet Braces.

1165. CLARKE, T. A. W., Havelock Works, Leicester.—Wood Planing Machine.

1166. BARLOW, H. B., JUN., & CO., Cornbrook Works, Manchester.—(1) An Expanding Mandrel, for lathes and other machines [Harrison's Patent]. (2) Barlow's Patent Face-plate Expanding Mandrel. (3) Improvements in wire heads and harness, and in head shafts.

1167. HOUGHTON, S. A., Training School for Engineer Students, Devonport, Devonshire.—Portable Electric Drilling Machine, for metals, a substitute for the ratchet brace.

1168. ANDERSON, R. F., 84 Commercial Street, Dundee.—Universal Elevator, for fire escape, building, agricultural, and military operations, &c.; can be raised and lowered with speed and facility.

1169. MCCOLLEY, HENRY, Cadogan Iron Foundry, Stanley Bridge, King's Road, Chelsea, S.W.—Lock Mortising Machine.

1170. WEST, THOMAS, & CO., Devon's Road, Bromley-by-Bow, E.—Emery Wheels.

1171. THOMPSON, CHARLES, Ardagh House, near Kingscourt, Co. Cavan, Ireland.—Apparatus to adapt a lathe for slotting or planing metal, or other hard substance.

1172. BATEMAN, A. H., East Greenwich, S.E.—(1) Emery Wheels and Grinding Machines. (2) Bolt and Screw-making Machines. (3) Stone Polishing, Breaking, and Crushing Stone. (4) Non-accumulator Hydraulic Pump, Artificial Stone, Machinery Bearings. (5) Bread Kneading Machine. (See also *Foreign Courts for machine in motion.*)

1173. HOLTZAPFEL & CO., 64 Charing Cross, London, S.W.—(1) Lathes and Tools for ornamental turning: Slide-rests, chucks, revolving and shaping tools and new inventions in automatic and other apparatus employed in this branch of the art. (2) Porter's Patent Cement Testing Machine.

1174. WILSON, J. S., 47 Northbrook Road, Southampton.—Machine for cutting off rivet heads.

1175. MARSDEN, FRANCIS, Slavo-nia Works, Sheffield.—(1) Improvements in machinery or apparatus for turning shafts, spindles, and other like cylindrical articles. (2) Patent Surface Grinding or Polishing Machine, and sample products.

1177. **VALDA, ALEXANDER H.**, 120 Duke's Road, Chiswick.—An improved arrangement for preventing wear of the cutting edge of plane irons during the return stroke.

1178. **JONES, R. K.**, Eureka Works, Birkenhead.—(1) Duplex Continuous Motion Ratchet Brace, with variable automatic feed motion. (2) Tube Plate Cutter. (3) Coal Perforator, for mining purposes. (4) [a] Annular Cutter, for cutting large holes in plate metal. [b] Ditto, for round or elliptical holes. [c] Ditto, for steam-power. (5) Ratchet Boring Tool, for taper or parallel holes. (6) Instrument for marking and centering holes on metal.

1179. **MARTIN, ROBERT**, Old Charlton, Kent.—Improvements in Drills, Milling Cutters, Rimers and other miscellaneous tools.

1181. **REYNOLDS, F. W., & CO.**, Acorn Works, Edward Street, Blackfriars Road, London, S.E.—Wood-working Machinery, viz.:—(1) Patent Mortising Machine, The Monarch. (2) Patent Mortising Machine, The Eclipse. (3) Patent Combined Planing, Coredriving and Boring Machine, The Southwark. (4) Patent Floor Cramp, The Crown. (5) Improved Mitre Cutter.

1182. **EVANS, J. H.**, 160 Wardour Street, Soho, London, W.—(1) Ornamental Turning Lathes and Apparatus connected with decorative and fine art turning. (2) Newly Invented Automatic Counting Apparatus and Automatic Fluting Stops for ornamental turning slide-rest, and specimens of their productions.

1183. **SMILES, J. H.**, 1 Carr Street, Stockton-on-Tees.—Improvements in apparatus for cutting holes in metal plates.

1184. **SKINNER, J. A., & CO.**, Eastbourne.—The Improved Segment Moulding Machine.

1185. **PHILLIPS, CHAMBERS, & CO.**, 69 Holborn Viaduct, London, W.C.—(1) The Eclipse Jaw Chucks for lathes. (2) Eclipse Patent Clamp.

1186. **SLACK'S EMERY WHEEL AND MACHINE CO.**, Limited, Lime Bank Works, Ardwick, Manchester.—(1) Improved Automatic Grinding Machine for planing machine knives. (2) Improved 4-in. Single Tool Grinder, with centrifugal pump and hand gearing for rotating disc slowly and truing up.

1187. **WILLIAMSON, GEORGE**, The Great, Holbeck, Leeds.—Improvements in machines for cutting nails and sprigs.

1188. **ANDERSON & GALLWEY**, Creborne Works, Lot's Road, Chelsea, London, S.W. (See Group XI.)

1189. **BAXTER, W. H., & CO.**, Albion Street, Leeds. (See Group II.)

1190. **BEZER, HENRY**, 12 Teddington Park Road, Teddington. (See Group XII.)

1191. **BOWLING IRON CO.**, Limited (THE), Bradford. (See Group IV.)

1192. **CHUBB & SON'S LOCK & SAFE CO.**, Limited, 128 Queen Victoria Street, London, E.C. (See Group XXIV.)

CUTTELL, F. G., 49 Bedford Street, Strand, London, W.C. (See Group XXX.)

DEIGHTON, W., Workington, Cumberland. (See Group II.)

EDWARDS, G., Whitby Lodge, New Thornton Heath, Surrey. (See Group XXVIII.)

FAULL, E. M. B., 30 Manley Terrace, Kennington Park, London, S.E. (See Group IV.)

FIELDING & PLATT, Atlas Iron Works, Gloucester. (See Group XI.)

GARRETT, R., & SONS, Leiston Works, Leiston, Suffolk. (See Group I.)

GIBBONS, HENRY, Kennet Works, Hungerford. (See Group II.)

GILBERT, GLOSSOP, & STACEY, Heeley Bridge Foundry, Sheffield. (See Group XI.)

GÜLCHER ELECTRIC LIGHT & POWER CO., Limited, 4 Coleman Street, London, E.C. (See Group XIII.)

HARDY PATENT PICK CO., Limited (THE), Sheffield. (See Group II.)

TYLER, HAYWARD, & CO., 84 & 85 Whitecross Street, London, E.C. (See Group II.)

HYDRAULIC ENGINEERING CO., Limited (THE), Palace Chambers, Westminster, London, S.W. (See Group XI.)

JOHNSON, WILLIAM, Cardigan Works, Leeds. (See Group III.)

LINES & BRIDGEMAN, 108 Golden Lane, London, E.C. (See Group XI.)

MASSEY, B. & S., Openham, Manchester. (See Group II.)

PATENT EXHAUST STEAM INJECTOR CO., Limited (THE), 4 St. Ann's Square, Manchester. (See Group IV.)

PATENT (METAL) DIE CO., Limited, 29 Addington Street, York Road, London, S.E. (See Group XI.)

PHOSPHOR BRONZE COMPANY, Limited (THE), 87 Sumner Street, Southwark, London, S.E. (See Group II.)

PLUMPTON, GEORGE, Albion Tool and File Works, Warrington, Lancashire. (See Group XXIV.)

SALMON & CO., Victoria Works, Kettering, Northamptonshire. (See Group XVIII.)

SHARP, STEWART, & CO., Limited, Atlas Works, Manchester. (See Group XI.)

SMITH, HUGH, & CO., Fossil Works, Glasgow. (See Group XI.)

STERNE, L., & CO., The Crown Iron Works, Glasgow. (See Group XI.)

SWINDELLS, JAMES, 37 Chatham Street, Stockport. (See Group XI.)

TANGYE BROTHERS, Cornwall House, 35 Queen Victoria Street, London, E.C. (See Group XI.)

TULLY, WILLIAM, & CO., 123 Queen Victoria Street, London, E.C. (See Group IV.)

CHATWOOD'S

PATENT "INVINCIBLE"

SAFES, LOCKS,

AND

BANKERS' STRONG ROOMS,

AND

CHATWOOD'S PATENT INCANDESCENT LIGHT,

East Arcade, Group XV., Stand 159.

CHATWOOD'S PATENT HYDRAULIC BALANCE ELEVATOR.

No. 1. Shows Elevator overbalanced by Dead Weight.

" 2. " " " by Head of Water.

" 3. " " underbalanced by Dead Weight.

" 4. " " " by Head of Water.

The Unbalanced Weight being taken by Water in Small Supplementary Cylinders which is alone lost.

WEST ANNEXE, GROUP XI., STAND 36.

*PATENT SAFETY SELF - ACTING RAILWAY
CARRIAGE-DOOR LOCKS.*

GROUP V. STAND 289.

76 NEWGATE STREET, LONDON.
Manufactory: BOLTON.

HYDRAULIC MACHINES, PRESSES, MACHINES FOR RAISING HEAVY WEIGHTS, WEIGHING, &c.

By SIR WILLIAM ARMSTRONG, C.B., D.C.L., LL.D., F.R.S., &c., &c.

THE progress which has been made in hydraulic machinery during the last twenty-five years has been very great, and has taken place chiefly in the direction of the utilization of hydraulic pressure transmitted from steam engines and accumulators. This system, which is of comparatively recent origin, was, in the first instance, chiefly limited to cranes, but was rapidly extended to the working of lock gates, sluices, capstans, movable bridges, and other machinery used in dock operations, and to the loading and discharging of ships at coal ports, as well as to various purposes connected with railway stations. At first the power used for this kind of machinery was taken from town water-pipes, or from elevated tanks, or large air-vessels, into which the water was pumped by the action of a steam-engine; but these methods of supplying and storing the necessary power were subsequently superseded, except in some special cases, by the introduction of the accumulator, which enabled very high pressures to be used, and enormously reduced the dimensions of the pipes for transmitting the power, and of the machinery for using it.

All this took place prior to the commencement of the limit of twenty-five years fixed for the scope of the approaching Exhibition; and the inventions of a subsequent date consist chiefly of developments of the same principle, and also in a wider and more comprehensive use of the Bramah press.

A very important branch of this subject consists in the application of hydraulic pressure machinery to various workshop operations, under which category may be specially noticed the forging by hydraulic pressure instead of by hammers. Forging presses upon this principle are now being constructed of enormous dimensions, and capable of dealing with masses exceeding in weight anything hitherto attempted to be forged.

Machines actuated by hydraulic pressure are also now largely used for riveting, flanging, and stamping, and for various motive purposes in workshops where the direct action of a steam-engine would be impracticable or inconvenient. Another branch of this subject, which has originated within the period in question, is the application of hydraulic machinery for the purpose of controlling the recoil, and effecting the various movements involved in the working of ordnance, especially where the weight and magnitude of the guns and their fittings are too great for the employment of manual labour. This system comprises a great variety of mechanical combinations, and has been extensively introduced into the navies and land defences of this and other countries. It has also been applied both in war ships and trading vessels for various miscellaneous purposes, such as for steering, for starting the engines, for working capstans, and for hoisting.

Under the head of cranes and lifting machines much has been done. The original cranes fixed to foundations necessitating the mooring of vessels at particular berths and restricting the manœuvre power to the fixed machinery there provided, but within very recent years hydraulic cranes have been made movable, so that all the hatchways of a large ship can be worked at the same time and at any point where the ship can be conveniently berthed.

The system of direct-acting lifting cylinders, suspended in a cupped joint or gimbals, to allow the cylinder to adjust itself to the angle of lift, has also been recently introduced and extensively applied for raising extremely heavy weights, so as to avoid the risks attending the use of chains.

Lifts for high buildings are also coming very extensively into use, and the system of supplying pressure water from central sources for this and other purposes in large towns has of late years been put in practice. By a novel invention the water thus supplied at a high pressure can be made indirectly available for the extinction of fire. This is done by using a small jet of high pressure water to carry with it a large volume of low pressure water derived from the

adjacent pipes for domestic service. The hoists for high buildings have been made in a great variety of form, the objects being to attain safety, and to meet the conditions both of high and low pressure water, and considerable ingenuity has been exercised in realising these objects. Within the last twenty-five years, hydraulic transmitted power has been successfully used in tunnelling operations, and although discontinued for a time is now again attracting attention, and is in some instances again being employed in substitution of compressed air.

Corn warehouse machinery for effecting all the operations necessary for the lifting, distribution, and cleaning of imported grain, has of late years been extensively introduced, and in most cases it is found advantageous to employ transmitted water pressure as the motive power for this machinery in preference to steam directly applied.

In the construction of the Alexandra Docks now in progress at Hull, where hydraulic power is ultimately to be applied for the usual purposes in mercantile docks, the steam-power and accumulators have been erected as a first step in the construction of the docks, in order that the power might be applied to the excavation of the dock, the driving of piles, and the lifting of materials for the building and backing of the walls. Many of the machines used for this purpose are the ordinary cranes, jiggers, and capstans, which will be used on the completion of the dock for the usual trade purposes, while others have been specially designed for the operation of construction. This is one of the new developments of the utilization of power transmitted by water which is likely to meet with extensive application in future, and to afford an opening for further inventions.

The steam-engines for pumping water into accumulators have, of late years, been greatly improved by the adoption of the compound principle and other means of effecting economy. Although steam is generally used as the source of power, there are some few cases in which natural waterfalls have been made available for this purpose, and it is probable that in favourable localities this method of producing hydraulic pressure for transmission will be extensively adopted.

GROUP XI.—HYDRAULIC MACHINES, PRESSES, MACHINES FOR RAISING HEAVY WEIGHTS, WEIGHING, &c.

WEST ANNEXE.

[For Hay and Straw Elevators, see Group I.; for Elevators used in Building, see Group III.; for Hydraulic Rams, see Group IV.; for Grain Elevators, see Group XVII.; for Chemical, &c., Balances, see Group XXVIII.]

1191. PRICE'S PATENT CANDLE CO., Limited, Belmont Works, Battersea, London, S.W.—(1) Improvements in the manufacture of self-fitting candles. (2) New Method of making snuffless dip candles. (3) Improvements in the manufacture of plaited wicks for candles.

1192. FIELD, J. & J. C., Lambeth Marsh, London, S.E.—(1) Soaps. (2) Detergents. (3) Disinfectants. (4) Night Lights. (5) Candles. (6) Candle Machines.

1193. FIELDING & PLATT, Atlas Iron Works, Gloucester.—(1) Tweddell's system of Hydraulic Machine Tools and other Labour-saving Appliances. Manufactured by them under Tweddell, Platt & Fielding's Patents. Exhibited in operation. (2) High-Speed Rotary Steam Engine, suitable for driving dynamo machines, steam launches, &c.

1194. BECK & CO., Limited, 139 Great Suffolk Street, Southwark, London, S.E.—(1) Rotary Pressure Blower, Gas Exhauster or Pump [Rollason's Patent], for blowing cupolas, smelting furnaces, blacksmith's forges, ventilating mines, tunnels, and buildings, pumping water, sewage, tar, irrigating purposes, &c.; only two moving parts. (2) The Comet Patent Rotary Pump, for thin or thick liquids; runs at slow speed; has only two working parts.

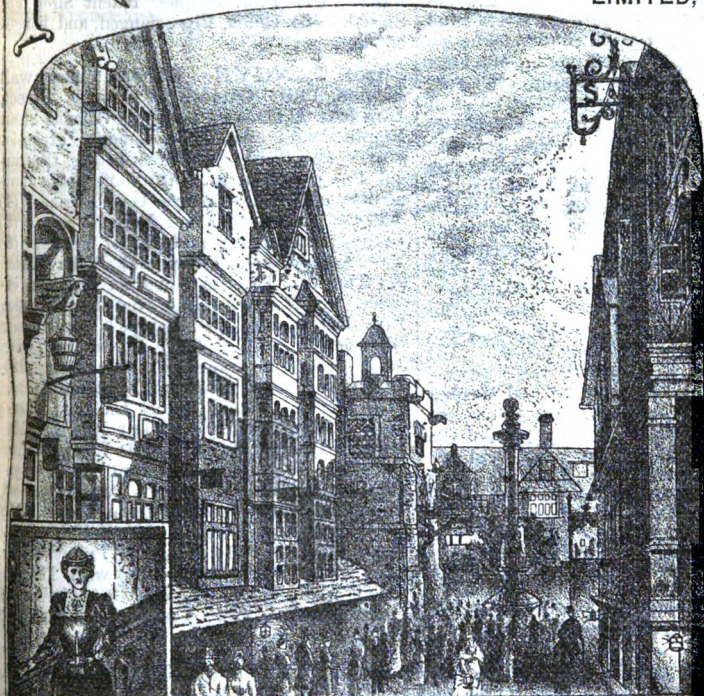
1195. HATHORN, DAVEY, & CO., Sun Foundry, Leeds.—(1) Differential Valve Gearing for pumping engines. (2) Compound Pumping Engines. (3) Domestic Motor or Safety Engine for pumping, electric lighting and other purposes. (4) Improved Deep Well Pumps. (5) Piston Water Meter. (6) Hydraulic Pumping Engine.

1196. APPLEBY BROS., 89 Cannon Street, London, E.C.—(1) Portable or Locomotive Steam Crane. (2) Cranes driven by ropes. (3) Falling Bracket Bearings. (4) Independent Whip Crane. (5) Model of Gold Quartz Reduction Mill.

1197. WARNER, JOHN, & SONS, Crescent Foundry, Cripplegate, London, E.C.—(1) Rackham's Steam Engine Automatic Positive Expansion Gear. (2) Rackham's Patent Steam Pump Condenser and Steam Pump. (3) Goslin & Rackham's Improved Chain Pump. (4) Goslin's Patent Expansive Boiler Cocks.

PRICE'S PATENT CANDLE COMPANY

LIMITED,



are daily showing
in the Western
Annexe (near the
West End of Old
London) the
manufacture of
their
**GOLD MEDAL
PALMITINE
CANDLES,**
with improved
Self-fitting ends,
—Moulded Spiral
Candles, also with
Self-fitting ends,
—Snuffless Dips
by a new method,
and the Plaiting
of Candle wicks
by Improved
Machinery.

OLD LONDON.

PRICE'S PATENT CANDLE COMPANY, Limited,

ARE THE

LARGEST CANDLE MAKERS IN THE WORLD.

Their Works are situated at Battersea on the Thames and Bromborough
Pool on the Mersey.

PRICE'S GOLD MEDAL PALMITINE CANDLES,

with Improved Self-fitting Ends, are the best Candles for Dining and Drawing Rooms.

PRICE'S CHILDS' NIGHT LIGHTS.

PRICE'S NEW PATENT NIGHT LIGHTS.

PRICE'S PURE GLYCERINE FOR MEDICINAL PURPOSES.

The first Pure Glycerine ever manufactured. Guaranteed absolutely pure.

31 Diplomas of Honour, Gold, Silver, and other Medals

HAVE BEEN AWARDED TO

PRICE'S PATENT CANDLE COMPANY LIMITED,

LONDON AND LIVERPOOL,

From whom Lists of their numerous Manufactures may be obtained,

1198. SMITH, HUGH, & CO., Possil Works, Glasgow.—(1) Construction of Iron and Steel Ships. (2) An Arrangement for hydraulic cranes, winches, hoists, lifts, and the like. (3) Multiple Drilling Machines. (4) Patent Boiler-Riveting Machine, with arrangement for varying the pressure on rivets from 140 to 30 tons, to suit the different thicknesses of plates. (5) Ship's Keel-Riveting Machine, to give 100 tons or any less pressure on rivets. With portable travelling carriage. (6) Patent Portable Lever and Bow Riveting Machines for ship's frames, bridgework, tanks, &c., with patent hydraulic hoist for raising and lowering riveting machines. (7) Patent Boiler Flange, Furnace, and Manhole Riveter, with variable pressures on rivets up to 90 tons. (8) Improved Accumulator, with direct-acting pressure pumps, with steam cylinder. (9) Improved Hydraulic Pressure Pumps, with belts. (10) Patent Hydraulic Flanging and Forging Machine, for flanging boiler ends, spherical dome ends, &c., and for compressing iron and steel. (11) Patent Hydraulic Crane, with three powers and three speeds, having racking and turning motions. (12) Patent Hydraulic Crane, for carrying portable riveters to any part of the ship. (13) Patent Hydraulic Hoist, with two powers and two speeds. (14) Patent Riveting Machine, for flush riveting ship plates.

1199. HYDRAULIC ENGINEERING CO., Limited (THE), Chester; and Palace Chambers, Bridge Street, Westminster, London, S.W.—(1) Compound Steam Pumping Engines for hydraulic power supply. (2) Hydraulic Capstans. (3) Hydraulic Engines of variable power. (4) Hydraulic Crane of variable power. (5) Hydraulic Balance Direct-acting Lift, compensating also for varying weight of ram. (6) Hydraulic Accumulator. (7) Hydraulic Machine Tools [punching, shearing, bending]. (8) Hydraulic Main Stop Valves. (9) Hydraulic Pipes. (10) Water Meters [positive action].

1200. WAYGOOD, R., & CO., Falmouth Road, Great Dover Street, London, S.E.—(1) Bennison's Patent Rotary Engine. (2) Bennison's Patent Pump, with Engine combined. (3) Waygood's Patent Direct-acting Hydraulic Lift, with Pump and Accumulator. (4) Waygood's Patent Hand Lifts, single and double. (5) Single Steam Lift. (6) The Hand Lifts, with Waygood's Patent Self-sustaining Break, to raise or lower by hand rope, or lower on the break. (7) Model of Waygood's Patent Hydraulic Balanced Lift, doing away with chains or ropes. (8) Model of Waygood's Patent Continuous Passenger and Goods Lift.

1201. PULSOMETER ENGINEERING CO. (THE), Limited, Nine Elms Iron Works, London, S.W.; and 61 & 63 Queen Victoria Street, E.C.—(1) The Pulsometer, a Pistonless and Frictionless Steam Pump, with no moving parts except the

very simple valves. (2) The Deane, Direct-Acting Pumping Machinery, for higher lifts than the Pulsometer can deal with [over 100 feet]. (3) The Thames Filter, for purifying continuously large quantities of turbid water. (4) Prof. Holmes' Patent Siren Fog Signal. (5) Union Pipe, flanged, and flanged bends.

1202. TANGYE BROS., Cornwall House, 35 Queen Victoria Street, London, E.C.—(1) Tangye's Colonial Steam Engine, with patent automatic expansion gear. (2) Tangye's Direct-acting Centrifugal Pumping Engine, with Jefferiss' improvements. (3) The Tangye Gas Engine. (4) Jefferiss' Ram Pump and Boiler Feeder. (5) Barnes' Ram Pump and Boiler Feeder. (6) The Special Ram Pump and Boiler Feeder. (7) Tangye's Electric Governor for steam engines. (8) Tangye's Improved Double Action Fly-wheel Pump. (9) Tangye's Gas Hammer [Robson's Patent]. (10) Hydraulic Lifting Jack. (11) Hydraulic Pulling Jack. (12) Tangye's Patent Horizontal Steam Engine. (13) Morton's Patent Retort Lids and Fastenings. (14) Stroudley's Patent Ramps. (15) Marks' Patent Hoist. (16) Steam Engine Cylinder, with Jefferiss' patent automatic expansion gear. (17) Cherry's Patent Overhead Traveller. (18) Special Steam Pump. (19) Cherry's Patent Hoist. (20) Self-Sustaining Rope Blocks. (21) Dynamic Pulley Blocks. (22) Weston's Pulley Blocks, with Tangye's patent chain guides. (23) Cherry's Patent Brake Block. (24) Compound Condensing Steam Pumping Engine.

1203. WILLIAMS, THOMAS H., A.M.I.C.E., F.S.A., 11 Queen Victoria Street, London, E.C.—Williams' Patent Direct-acting Steam Pump. The main valve of the engine receives its motion from a supplemental piston. The deep valves have interchangeable beats.

1204. SWALWELL & MOORE, Acre Street, New Road, Battersea, London, S.W.—(1) Improved Pulley Blocks. (2) Improved Hoists. (3) Improved Sheave Pulley Blocks.

1205. KIRKLAND & SON, West Gate Works, Mansfield.—An Improved Brake for pulley blocks, also rendering them self-sustaining.

1206. THOMPSON, W. H., 68 Chiswell Street, London, E.C.—Thompson's Rotary Ram.

1207. BURGESS, W. J. & C. T., Victoria Works, Brentwood, Essex; and Holborn Viaduct, London, E.C.—Water Lift for bullock or horse power, capable of raising 2000 gallons per hour when worked by one bullock, or 3000 gallons per hour when worked by one horse. Usually employed for irrigation from wells about 30 feet deep.

1208. GADSDEN, H. A., 6 Crosby Square, Bishopsgate Street, London, E.C.—Liquids and Gas Pumps.

1209. CUMMINS, A. E. (care of OREROD, GRIERSON, & CO., St. George's Ironworks, Manchester).—Improvements in baling Cotton and in Presses for that purpose.

1210. HILL, F. B., 69 Camplin Street, New Cross Gate, London, S.E.—(1) Improvements in apparatus for the lifting and recharging of fluids. (2) An Improved Hydro-mechanical Accumulator.

1211. FOULIS, JOHN, 28 Market Street, Musselburgh, Midlothian, N.B.—An Improved System for draining, consolidating, and solidifying paper sludge, sewage, distillery dregs, &c.

1213. SHARP, STEWART, & CO., Limited, Atlas Works, Manchester.—Bottomley's Patent Radial Axle Box or Truck. (2) Hamer, Metcalf, & Davies' Exhaust Steam Injectors. (3) Improved Patterns of Giffard Injectors. (4) Novel Seller's Planing Machine. (5) Improved Suspended Boiler Drilling Machine. (6) Portable Keyway Drilling Machine.

1214. SMITH, B. G., Stannary Street, Exeter.—Hydraulic and Telescopic Hoist and Hydraulic Crane.

1215. GLOSSOP & STACEY, Heeley Forge Foundry, Sheffield.—(1) 2 cwt. Standard, Self-acting Steam Hammer tilting, fork drawing, &c. (2) 2 cwt. Standard Steam Hammer, to work self-acting and by hand, and give a dead blow for forging, for general smith work, gun barrels, all kinds of forgings. (3) 1 cwt. Single Standard Steam Hammer, with foot motion, for smith work, blade and file forging, &c.

1216. SELIG, SONNENTHAL & CO., Queen Victoria Street; and Lam Hill, E.C.—(1) Automatic Band-saw Machine. (2) Patent Planing Machine with power. (3) Turret Head Lathe with improved tools. (4) Railway Wagon Locomotive Shunting Apparatus and Railway Machine. (5) Wire-covering Machine and Rotary Pumping Engines.

1217. HOPKINSON, F., & CO., Sheffield.—(1) Patent Safety Valves and Indicators.

1218. LADD, JOHN H., & CO., 116 Queen Victoria Street, London, E.C.—The Boomer Patent Presses for baling of all descriptions; also for the use of bookbinders, &c. (2) Model of Perforating Press, for baling hay, straw, and fibres of all kinds.

1219. HORN, THOMAS, & SONS, 100 Strand, Waterloo Road, London, W.—Greenaway and Kitt's Patent Four-slide Master and Pump for gas, air, and liquids.

1221. ATTWOOD, A., & CO. (late SALMON, BARNES & CO.), Canal Head Foundry and Engineering Works, Ulverston, Lancashire.—(1) Hydraulic Direct-acting Lifts. (2) Hand Power Self-sustaining Lifts and Hoists.

1222. EAST FERRY ROAD ENGINEERING WORKS CO., Limited, East Ferry Road, Millwall, London, E.—(1) Duckham's Patent Hydrostatic Suspended Weighing Machine, self-indicating for attachment to cranes, &c. (2) Models of Parkes' Patent Moveable Hydraulic Cranes. (3) Models of Parkes' Patent Self-counter Balanced Moveable Hydraulic Cranes. (4) Models of Improved Hydraulic Lifts, &c.

1223. RICHMOND, JOSEPH, & CO., 30 Kirby Street, Hatton Garden, E.C.; and New Sun Iron Works, Bow, London, E.—Telescopic Hydraulic Lift, for passengers or goods, in which all the sections move simultaneously and at equal speed.

1225. BAXTER & CO., 18 & 19 Great St. Helens, London, E.C.—Working Chain, Cables, and Wire Rope.

1226. STERNE, L., & CO., The Crown Iron Works, Glasgow.—Emery Wheels and Emery Grinding Machinery.

1228. WORTHINGTON PUMPING ENGINE CO., 114 Queen Victoria Street, London, E.C.—(1) Worthington Steam Pumps. (2) Worthington Water Motor. (3) Worthington Water Meter.

1231. CLARK, BUNNETT, & CO., Rathbone Place, Oxford Street, W.—Duplex Hydraulic Lift, with pump and accumulator.

1232. CHATWOOD, SAMUEL, Bolton; and 78 Newgate Street, London, E.C.—(1) Elevator, overbalanced by dead weights. (2) Elevator, overbalanced by head of water. (3) Elevator, underbalanced by dead weights. (4) Elevator, underbalanced by head of water.

1233. BERNAYS, JOSEPH, 96 Newgate Street, London, E.C.—Improvement in Direct-acting Steam Pumps and Fluid Pressure Engines, with fly-wheel motion, greatly reduced in bulk and weight, the piston stroke being four times the length of crank.

1234. SWINDELLS, JAMES, 37 Chatham Street, Edgeley, Stockport.—Improvements in Machinery for trenching or slotting wood transversely or diagonally.

1235. COLLINGHAM, R. M., Green Lane Foundry, Hull.—Machine for compressing blue, blacklead, and other substances.

1236. GEORGE, S., 80 Cumberland Street, Warwick Square, Pimlico, London, S.W.—Rotary Pump, reversible. Slow speed, either manual or steam, for acids or any liquid where metal cannot be used.

1236. LINES & BRIDGMAN, 108 Golden Lane, London, E.C.—Nailing Machine for manufacture of wooden boxes and packing cases.

1238. WESTINGHOUSE BRAKE CO., Limited (THE), Canal Road, King's Cross, London, N.—(1) Direct-acting Pumps for air, vacuum or water. (2) Automatic Air Brakes and Passenger Communication for railway trains.

1239. PHOENIX METAL DIE & ENGINEERING CO., 29 Addington Street, York Road, Lambeth, London, S.E.—(1) Slip Hooks [Bezer-Thomas Patent] for releasing under strain or automatically, for various purposes. (2) Steel Dies for hot forgings and stamping in metals, including medal, coin, and jewellers' and silversmiths' dies.

1240. KÖRTING BROS., 11 Pancras Lane, Queen Street, London, E.C.—Aquadult, a new steam pump.

1241. KITE, JAMES, & CO., Phoenix Iron Works, 220 Upper Kennington Lane, Vauxhall, London, S.E.—Original Patentees of Filter Presses for High Pressure, with chambers in combination, and new mode of high pressure filtration, either of textile fabrics or papers.

1242. ANDERSON & GALLWEY, Cremorne Works, Lot's Road, Chelsea, London, S.W.—Hydraulic Rivetters of the most recent types: punching, shearing, bending, forging, hoisting, and other high pressure hydraulic machinery.

[The following Exhibits of this Group will be found in the East of Queen's Gate Annexe.]

1253. WATKINSON, ROBERT, 12 Gore Street, New Bailey Street, Salford, Manchester.—(1) Instantaneous Couplings for connecting fire brigade hose and other pipes. (2) Improved Metal Ferrules for attaching hose pipes to unions, dispensing with wire wrapping.

1254. LEIGHS, A. L. S., Novelty Works, Deptford, London, S.E.—(1) An automatical extending and collapsing, self-supporting crane and lift Fire Escape, applicable for business and domestic purposes. (2) Extending and Collapsing Ladder.

1256. IMMS, JAMES, 79 Alma Street, Aston, Birmingham.—Improved Portable Domestic Fire Escape.

1257. MORRELL, JAMES C., 48 Ann's Square, Manchester.—Improvements in Fire Escapes.

1258. HARGREAVES, HENRY, 92 Osborne Road, Forest Gate, London, E.—Window Fire Escape.

1243. COLES, HENRY J., 89 Sumner Street, Southwark, London, S.E.—(1) Steam Crane, improved type, with Cole Patent Live Bing Slewing Gear. (2) Cole Patent Grab and Bucket Dredger.

1244. EASTON & ANDERSON, Whitehall Place, London, S.W.; and Erith, Kent.—(1) Rich's Patent Adjustable Turbine, working a patent adjustable centrifugal pump. The powers of the turbine pump can be varied by raising and lowering their fans into and out of annular troughs, the edges of which partially close both the receiving and discharging apertures; such turbines are in use also for electric lighting. (2) Parts of hydraulic lifts for Mersey Tunnel Railway for raising passengers to the surface stations. There are six such lifts, each capable of raising 80 to 100 people. (3) High Pressure Air-compressing Pumps for charging tyres. (4) Model of Bell, Stoney & Bell Patent Hydraulic Ferry Steamer for the rivers. (5) Hydraulic Passenger Lift Royal Albert Hall.

1245. SMITH, ARCHIBALD, STEVENS, "Janus" Works, Queen's Road, Battersea, London, S.W.—(1) Hydraulic Suspended Passenger Lifts. (2) Hydraulic Balance Passenger Lifts. (3) Hydraulic Single Action Door Spring. Hydraulic Accumulator and Pumps. Self-sustaining Lifts.

1246. BARKER, JOHN, & SONS, Limited, Park Street Iron Works, Oldham.—(1) Patent Self-landing and delivering Hoist. (2) Patent Automatic Self-opening and Self-closing Doors for Lifts, hotels, mills, factories, warehouses, &c.

1259. GEORGE, S., 30 Cumberland Street, Warwick Square, London, E.—Portable Fire Pump or Engine.

1260. GAGE, WILLIAM HENRY, Union Street, Kingston-on-Thames, Surrey.—Improved Household Fire Escape for general use, so constructed and fixed it may be used from the several floor levels at the same time.

1261. GIBBS, JOHN, 18 Carrington Street, Glasgow.—Improved Challenge tincture.

1263. ST. GEORGE-CUFF, A., Captain, 45 Powis Square, London.—Improvements in Balconies by which they be used as fire escape ladders.

1264. HARDEN "STAR" H. GRENADE FIRE EXTINGUISHING COMPANY, Limited (THE), 1 Holloway Viaduct, London E.C.—Fire Extinguishers.

1265. GLYDON, GEORGE, 40 Oozells Street, Birmingham.—Improvements in Universal Union or Coupling for hose, tubes, shafts, air brakes, &c.

1266. **MONK, J. W. G. G., 476 Rotherhithe Street, Rotherhithe, Surrey.**—Automatic Tallying Weighing Machine.

1267. **POUPARD, THOS. JAMES, 3 Teoley Street, London, S.E.**—(1) Patent Coo Weighing Machine, Sack Holder & Elevator combined. (2) The Unique Up Weighing Machine.

1269. **LEONARD & SMIRKE, 8 Abing's Court, Charing Cross, London, W.**—Automatic Fire Extinguisher and Alarm.

1272. **DAVY, WILLIAM THOMAS, Valentine Place, Blackfriars Road, London, S.E.**—A Fire Escape applicable for painting and painting windows, fronts of houses, &c., without the use of ladders or standing on window sills.

1274. **BECK, JOHN, TRUELOVE, & COMPANY, 30 Leipsic Road, Camberwell, London, S.E.**—(1) Tell-tale Taps and Valves for measuring liquids, and for indicating the quantity drawn off. (2) An Improved Sluice Valve or Cock designed to close against fire, for opening and shutting quick without concussion. (3) Special construction in chinaware, of sanitary fittings.

1275. **CLOWES, WILLIAM WARREN, High Street, Harrow, Middlesex.**—The Harrovia Portable Domestic Fire Escape.

1276. **BEAUCHAMP, MAJOR C. S., George Hotel, Queen Street, Glasgow, N.B.**—Automatic protection of houses and buildings from fire.

1278. **SHAND, MASON, & CO., 75 Upper Ground Street, Blackfriars Road, London, S.E.**—(1) Patent Equilibrium Steam Fire Engine with patent inclined tube boiler. (2) Volunteer Steam Fire Engine with patent boiler. (3) Patent Instantaneous Hose Coupling. (4) Patent Lever Clip, Working Pin, Sway Bar Disengaging Apparatus, Crab, Corridor Engine, London Brigade and Pump, Chemical Engine, Hydrants, &c., &c.

1279. **MERRYWEATHER & SONS, Greenwich Road, S.E.; and 63 Long Street, London, W.C.**—(1) Steam Fire Engine, Greenwich pattern, of new design and improved construction. (2) Steam and Manual Fire Engines, with latest improvements. (3) Portable Steam Pumping Engine. (4) Stationary Steam Fire Engine for mills and fire floats. (5) Hall, Corridor, Toner, and London Brigade Portable Fire Engines and Chemical Extinguishers. (6) Hydrants, Fire Valves, Hydraulic Pressure Augmentor for firemen. (7) New Patent White Fabric Rubber Lined Hose, and other descriptions of Fire Hose. (8) Domestic Fire Escapes, Fire Buckets, &c.

1280. **POOLEY, HENRY, & SON, Albion Foundry, Liverpool.**—Improve-

ments in Weighing Machinery, especially as to the automatic indication of weight. Sundry Models of Compound Lever Weighing Machines, from Wyatt's weighbridge of 1744 [believed to be the first ever made] to Pooley's latest Railway Weighbridge.

1281. **AVERY, W. & T., Digbeth, Birmingham; and 14, 15, & 16 Cow Cross Street, London, E.C.**—(1) Improvements in lifting apparatus, including Patent Self-registering Steelyard [Chamero's Patent]. (2) Patent Knife Edges, Bearings, and jointed crank. (3) Patent system of levers applied to weighbridges. (4) Patent bread checking and other balances.

ANDERSON, R. F., C.E., 84 Commercial Street, Dundee. (See Group X.)

ASBESTOS CO., Limited (THE UNITED), 161 Queen Victoria Street, London, E.C. (See Group IV.)

AVERY, W. & T., Digbeth, Birmingham; and 14 to 16 Cow Cross Street, London, E.C. (See Group VII.)

AYRTON & PERRY, 73 Great Eastern Street, London, E.C. (See Group XIII.)

BARNETT & FOSTER, Niagara Works, Eagle Wharf Road, London, N. (See Group II.)

BATEMAN, A. H., East Greenwich, London, S.E. (See Group X.)

BATHO, W. F., 9 Victoria Chambers, Westminster, London, S.W. (See Outside, South Promenade.)

BEAUCHAMP, MAJOR C. S., R.E., George Hotel, Queen Street, Glasgow, N. B. (See Group VII.)

BECK, J., & F. M. TRUELOVE, 30 Leipsic Road, Camberwell, London, S.E. (See Group VII.)

BEVERIDGE, J., Soho Foundry, Barrow-in-Furness, Lancashire. (See Group IV.)

BROWN, A. C., 11 Old Broad Street, London, E.C. (See Group XIII.)

BUCKLEY, W., & CO., Patent Piston Works, Millsands, Sheffield. (See Group IV.)

BUTLER, SAMUEL, 127 Bute Road, Cardiff. (See Group XI.)

CHATWOOD, SAMUEL, Lancashire Safe & Lock Works, Bolton; and 76 Newgate Street, London, E.C. (See Group XV.)

CLARK & STANDFIELD, 6 Westminster Chambers, London, S.W. (See Group III.)

CLOWES, W. W., High Street, Harrow, Middlesex. (See Group VII.)

COALBROOKDALE CO., Limited, Coalbrookdale Iron Works, Shropshire. (See Group IV.)

CRISP, C. B., 1 Mount Pleasant, Barnsbury Square, London, N. (See Group VII.)

CUFF, A. ST. GEORGE, 45 Powis Square, London, W. (See Group VII.)

DAVY, WILLIAM THOMAS, 21 Valentine Place, Blackfriars. (See Group VII.)

DEIGHTON, W., Workington, Cumberland. (See Group II.)

DURHAM, CHURCHILL, & CO., 23 Leadenhall Street, London, E.C. (See Group IV.)

ELLINGTON & WOODALL, 9 Bridge Street, Westminster, London, S.W. (See Group IV.)

EMPSALL, SAMUEL, Clay Pits, Halifax. (See Group III.)

FAULL, E. M. B., 30 Manley Terrace, Kennington Park, London, S.E. (See Group IV.)

FIDLER, T. CLAXTON, 13a Great George Street, Westminster, London, S.W. (See Group III.)

FIELD, WILLIAM, 1 Burlington Passage, Lower Temple Street, Birmingham. (See Group VII.)

FLETCHER, J. M., Cheadle, Cheshire. (See Group I.)

FRIBORG, JOHN, 76 Great Portland Street, London, W. (See Group VII.)

GAZE, WILLIAM HENRY, Fulham Palace Road, Fulham, London, S.W. (See Group VII.)

GEORGE, S., 30 Cumberland Street, Warwick Square, London, S.W. (See Group VII.)

GIBBS, JOHN, 18 Carrington Street, Glasgow. (See Group VII.)

GLOVER, WALTER T., & CO., 25 Booth Street, Manchester. (See Group IX.)

GLYDON, GEORGE, 40, 41 Oozells Street, Birmingham. (See Group VII.)

HALL, J. & E., 23 St. Swithin's Lane, London, E.C. (See Group X.)

HARDEN STAR HAND GRENADE FIRE EXTINGUISHER CO., Limited, 11 Southwark Bridge Road, London, S.E. (See Group VII.)

HARGREAVES, HENRY, 177 Romford Road, Stratford, London, E. (See Group VII.)

HEDICKE, M., & CO., 3 Adelphi Place, London Bridge, London, E. (See Group XVII.)

HEMMINGWAY, JOHN J., Dinning Street, Penistone Road, Sheffield. (See Group IV.)

HOCKEY & CO., Chard, Somerset. (See Group IV.)

HUNTER & ENGLISH, 202 Bow Road, London, E. (See Group III.)

IMMS, JAMES, 79 Alma Street, Aston, Birmingham. (See Group VII.)

JACKSON, J., 8 Frederick Place, Gray's Inn Road, London, W.C. (See Group IV.)

LEHMANN, A. J., 12 Delamere Street, Kirkdale, Liverpool. (See Group VII.)

LEIGHS, A. L. S., Novelty Works, Deptford, London, S.E. (See Group VII.)

LEONARD & SMIRKE, 8 Cranborne Court, Charing Cross, London, S.W. (See Group VII.)

LEWIS, W. T., & W. H. MASSEY, Aberdare; and Twyford, Berks. (See Group II.)

MACKENZIE, H. S., Penwenack, Falmouth. (See Group VII.)

MCCAW, WILLIAM J., Castle Canons, N.B. (See Group VII.)

MERRYWEATHER & SONS, Greenwich Road, S.E., and 63 Long Acre, London, W.C. (See Group VII.)

MONK, J. W. G. G., 476 Rotherhithe Street, Rotherhithe, Surrey. (See Group VII.)

MORRELL, J. C., 4 St. Ann's Square, Manchester. (See Group VII.)

MORTON, A., & THOMPSON, Buchanan Street, Glasgow. (See Group IV.)

NORRIS, S. E., & CO., 56 & 58 High Street, and St. Paul's Works, Shadwell, London, E. (See Group XX.)

PATENT EXHAUST STEAM INJECTOR CO., Limited (THE), 4 St. Ann's Square, Manchester. (See Group IV.)

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PHOSPHOR BRONZE CO., Limited (THE), 87 Sumner Street, Southwark, London, S.E. (See Group II.)

PICKERING, J., Globe Works, Stockton-on-Tees. (See Group III.)

POOLEY, HENRY, & SON, Albion Laundry, Liverpool. (*See Group VII.*)

POUPARD, T. J., 148 Tooley Street, London, S.E. (*See Group VII.*)

RANSOMES & PAPIER, 5 Westminster Chambers, Westminster, London, S.W.; & Waterside Works, Ipswich. (*See Group III.*)

RICHTER PATENT ECONOMISER MANUFACTURING CO. (THE), West Mills, Longside Lane, Bradford. (*See Group IV.*)

SANTLEBURY, WILLIAM, 15 Bridge Road, Lower Clapton, London, E. (*See Group VI.*)

SAND & MASON, 75 Upper Ground Street, Blackfriars Road, London, S.E. (*See Group VII.*)

SMITH, SYDNEY, & SONS, Basford Works, Nottingham. (*See Group*

STANECER, JOHN, & CO., Atlas Works, Keighley, Yorkshire. (*See Group I.*)

STOR, J. L., Gateshead-on-Tyne. (*See Group III.*)

TEEL, W. H., 116a Clapham Park Road, London, S.W. (*See Group III.*)

TROTHERT & PITT, Limited, London. (*See Outside, South Promenade.*)

THOMAS, T., & SONS, Acme Hoist Works, Cardiff. (*See Group III.*)

THOMPSON, C. H. & C. W., 22 Mordant Street, Brixton, London, S.W. (*See Group VII.*)

TRY, THOMAS, 4 Poland Street, Oxford Street, London, W. (*See Group III.*)

TUBINI, THEODORE, 29 Ladbrooke Gardens, London, W. (*See Group IV.*)

TYLER, HAYWARD, & CO., 84, 85 Whitecross Street, London, E.C. (*See Group II.*)

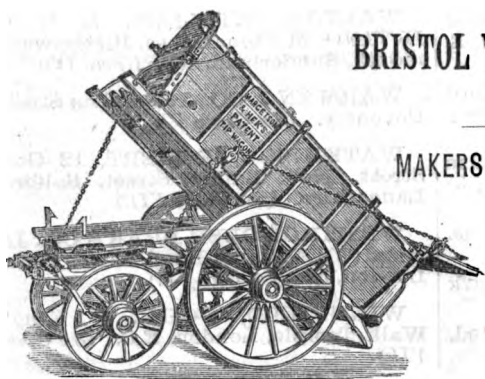
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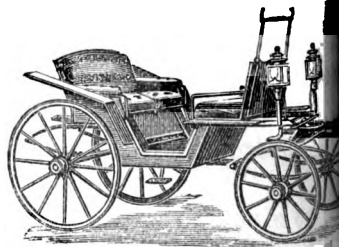
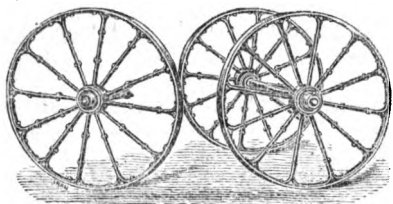
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GROUP XII.—ELEMENTS OF MACHINES.

SOUTH GALLERY, NORTH COURT.

224. **ARNOLD, SAMUEL**, 18 Barlowmew Road, Kentish Town, London, N.W.—Improvements in lock nuts.

225. **BEZER, HENRY**, 12 Teddington Park Road, Teddington.—Improved means of locking nuts, bolts and studs.

226. **CAMERON, LIEUT.-COL. D. R.A.**, Sheerness.—Coupling for the transfer of rotary motion between axes joined to one another.

227. **TAYLOR, W. W.**, Studley Park, Ripon.—(1) Turning Apparatus for raising or transferring, or reversing and transferring paper in the web or in sheets cut in the web. (2) Photographs of printing machines in which said turning apparatus is employed. (3) Circular Staircase specially constructed with a view to its admitting of being readily carpeted. (4) Epicycloidal

228. **HESLOP, M.**, 13 Queen Victoria Street, London, E.C.—An Adjustable Centric for varying or reversing the stroke in motion or at rest.

229. **HANKS, G. C.**, 9 South Street, Andrew's Street, Edinburgh. (See Group VI.)

230. **BUCKLEY, W., & CO.**, Patent Piston Works, Middlesbrough, Sheffield. (See Group VI.)

231. **WING, JAMES ALFRED**, University College, Dundee. (See Group IV.)

232. **ADLER, T. CLAXTON**, 13a Great

George Street, Westminster, London, S.W. (See Group III.)

HANSON, SCOTT, & CO., Stockport. (See Group IV.)

HARDING, C. W., King's Lynn, Norfolk. (See Group IV.)

JENKIN, FLEMING, 3 Great Stuart Street, Edinburgh. (See Group IV.)

MACKENZIE, H. S., Penwenack, Falmouth. (See Group VII.)

MARKHAM & CO., 345 Edgware Road, London, W. (See Group VI.)

PHOSPHOR BRONZE CO., Limited, 87 Summer Street, Southwark, London, S.E. (See Group II.)

PICKERING, JONATHAN, Globe Works, Stockton-on-Tees. (See Group III.)

ROCKING FIRE BAR SYNDICATE, Limited (THE), 259 Gresham House, Old Broad Street, London, E.C. (See Group IV.)

SALOMONS, SIR DAVID, Bart., Broomhill, Tunbridge Wells. (See Group XXVIII.)

TAYLOR, C., Edmund Street, Birmingham. (See Group X.)

TRIER BROS., 19 Great George Street, Westminster, London, S.W. (See Group IV.)

TYLER, HAYWARD, & CO., 84 & 85 Whitecross Street, London, E.C. (See Group II.)

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ELECTRICITY.

BY OLIVER J. LODGE, D. SC.

A QUARTER OF A CENTURY'S PROGRESS.

It is a matter of common knowledge that Electricity, whether considered as a science or as an art, has been advancing recently by leaps and bounds; but it is not always easy to recall how great has been the progress in a given period, because it is difficult to remember what was and what was not known at any given date. The object of the present historical sketch is to supply the necessary facts.

Going back in imagination twenty-five years, we find ourselves in 1860, thinking about a possible Atlantic cable which shall not snap as soon as laid, and hearing of various new devices to render the working of such long cables possible. Not till 1866 is America to be permanently joined to Europe, though the first momentarily successful attempt was made in 1857.

An electric workshop, distinct from telegraphy, is in 1860 unthought of. If we want a strong current we set up a Grove's battery, as has been done for twenty years back; we have no idea of the modern dynamo. Werner Siemens has indeed invented what is known now as the "old" Siemens armature (1854), and is constructing, with such an armature and permanent magnets, a large machine, which is to be an object of interest at the 1862 Exhibition. The idea of self-excitation is as yet non-existent, and the current of such a machine is far from steady. Though we know nothing of it, however, a quiet philosopher at Florence is even now constructing, on a new plan, a model electro-magnetic engine, which, though when made it does not appear anything remarkable, and is to be ignored rather than forgotten, yet is destined to be the recognised precursor of the host of gigantic dynamos of the present day—being in fact the *Gramme* machine in embryo.

The electric arc is familiar enough to physicists, for it is as old as the century, but the general public care nothing for it, and are blissfully ignorant that they will before long squander their money on it lavishly under the impression that it is a startling novelty. The incandescent lamp is still far in the future, for though several endeavours in the direction of incandescence in vacua have been made, nothing could be really accomplished with the extremely imperfect vacua then considered good. The Sprengel pump and Mr. Crookes' researches may be said to have rendered the permanence of an incandescent carbon filament possible.

The term "secondary battery," if used in 1860, would call up nothing more striking than Grove's gas battery and Ritter's secondary piles; but Gaston Planté is just beginning his researches, which are destined to lead, twenty years after, to the battery of Faure, and to who can tell what besides.

The telephone is as yet a thing of the future, for although Reiss is already at work devising a curious toy for the transmission of human speech by electricity, sixteen years must elapse before Graham Bell makes the telephone a household word and an indispensable worry to the man of business.

A wonderful type-printing telegraph has just been invented by Hughes, and a complicated machine it is; but it will gradually simplify itself down into the little glass-covered automatic printers now to be found in most large offices and clubs, working away without attention, and recording in a legible stream the price of stocks, the state of race betting, and other curious and apparently exciting information.

We have as yet no Holtz or other induction machines for conferring high potential on electricity, but are content with the method of rubbing glass practised in the last century.

Very few have any ideas on the subject of absolute electric measurement; the names, "ohm," "volt," &c., are not yet invented; it will be three years, indeed, before that coil is spun by a British Association Committee which will fix provisionally the absolute unit of resistance.

Modern electrometers do not yet exist, but both the quadrant and the absolute electro-

meters are being invented by Sir William Thomson; whose mirror galvanometer is also coming into general use as an improvement on the thirty-year-old instrument invented by Schweigger directly after Ersted's discovery.

The seeds of many great inventions were thus in 1860 being sown, and we may now glance rapidly at their order of development, traversing the subject in the classes as arranged in the catalogue.

CLASS 66. GENERATORS.—*1st. Continuous Current Electro-Magnetic Generators.*—The first powerful magneto-electric machine was that exhibited by Siemens and Halske, at the 1862 Exhibition. In 1866 Wilde used electric field magnets excited by a separate machine, and thus obtained powerful effects. The principle of self-excitation was discovered in 1867 by Ladd, Wheatstone, Varley, and Werner Siemens. The Gramme machine made its appearance in 1871; Alteneck improved the Siemens machine to its present form in 1872; and since then the modifications of one or other device are altogether too numerous to mention. The earliest attempt at a Gramme machine was the model made by Paccinotti, in Florence, about 1860, and described by him in 1863 or 1865, in a paper which set forth the whole principle in close detail.* The culmination of the Siemens form of machine is that known as the Edison-Hopkinson, and on this it is difficult to imagine very much improvement in the direction of efficiency; though in other directions, such as portability, compactness, and ease of manufacture, other machines have the advantage.

2nd. Alternating Electro-Magnetic Generators.—The old Holmes-Alliance machine with permanent magnets has culminated in the De Meritens. Wilde in 1867 employed electro-magnets in such machines, and, curiously enough, made them self-exciting at the same time, though this is not usually now done. The Siemens and Gordon forms of alternating machines are fairly well known; while that of Ferranti, with zig-zag winding, is very compact and powerful. Gaulard & Gibbs have recently proved that induction coils excited by alternating currents can be conveniently used for electrical illumination at a distance, without excessive waste of power and without dangerous potential at the lamps. Hopkinson has shown how to couple alternating machines together for various purposes, and his characteristic curve has done much to aid the improvement of continuous current-machines.

3rd. Electro-static Generators.—Varley in 1860, and Thomson in 1867, each re-invented Nicholson's "revolving doubler" of last century, and in 1865 Holtz brought out the machine which is so invaluable wherever high potential is required. By adding metallic contacts to it, Voss has quite recently made it self-exciting, and Wimshurst now makes large machines on a modified plan. Further progress may be well looked for in this direction, especially as commercial uses for such machines are already being discovered.

4th. Electro-chemical Generators.—In primary batteries we have nothing to record beyond a host of more or less unsuccessful endeavours after economy. But great interest is by many felt in this subject, and it is quite possible that something may in this direction be before long achieved.

Secondary batteries have practically come into existence in our period. The researches of Planté began in 1860; Faure patented his battery in 1880. Since then improvement has been in details, but very decided progress has been made.

5th. Thermo-electric Generators.—Here we have at present nothing new to record beyond the piles of Clamond, of Noë, and of Sudré, none of which can be said to be thoroughly and completely satisfactory.

CLASS 67. CONDUCTORS.—In view of the probable extension of electrical supply, the somewhat dry and arid details of "leads," of insulation, of joints, keys, and connexions, are of high importance. At present the system of Edison seems least incomplete. It is a department that can be trusted to grow rapidly as soon as the demand begins.

CLASS 68. TESTING AND MEASURING APPARATUS.—Methods of electric measurement have

* The writer is unable to agree with Dr. Andrews ('Nature,' vol. xii. p. 90) in attributing incorrectness to the diagrams in Dr. Paccinotti's paper, by reason of the armature poles being drawn at right angles to the poles of the field magnet. As produced by the armature's own current, that is where they are; and in explaining the machine as a motor, that is where they are best drawn. True, the language used is a little ambiguous, but it is not distinctly wrong; and it is incredible that the inventor of so ingenious a machine should fail to understand a simple point like that, whatever mistakes the mechanician employed to construct it may have made.

been completely revolutionised since 1860. The methods practised before that date now seem to belong to the infancy of the science. The labours of the British Association Committee, in 1868 and subsequent years, have resulted in a capital system of absolute units in use all over the world, and in the most accurate recent determination of the ohm by Lord Rayleigh.

The highly ingenious instruments of Ayrton and Perry have practically superseded ordinary galvanometers in the electric workshop, and new forms are still appearing.

Thomson's various electrometers gradually grew up between 1857 and 1870; some of them intended for extreme sensibility, some for absolute measurement, and some for portability. Recently Minchin has endeavoured to combine to some extent the two first properties in a measuring electrostatic gauge.

Several "transmission dynamometers," to indicate the force exerted by one machine on another while in action without wasting any energy, have been devised; their indicators requiring to be multiplied by the speed in order to give horse-power. Electric power-meters and erg-meters have also been invented, as well as several meters for measuring quantity of electricity, among which the chemical one of Sprague, and the magnetic one of Hopkinson, may be mentioned. Practical instruments for continuously recording electrical quantity or energy will before long be in great demand, and many attempts at such are sure to be exhibited.

CLASS 69. TELEGRAPHIC AND TELEPHONIC APPARATUS.—Land telegraphy was in a fairly advanced state before 1859, though type-printers and automatic transmitters have been invented since then. Duplex-telegraphy, or the simultaneous signalling of two independent messages along the same wire, had been devised by Gintl in 1853 as a laboratory experiment, but it was not made commercially practicable by Stearns in 1872; and in 1877 Muirhead succeeded in making a cable. Since then some lines have been quadruplexed, one wire serving for eight independent operators, four at either end.

As to marine telegraphy, many short cables were in use before 1860, but most of the present methods of working them have been invented since. In 1860 Varley patented his condenser; in 1867 Thomson invented the siphon-recorder, which records on paper the feeble currents received through 2000 miles of cable. In 1879 Cowper described his curious writing-telegraph.

Telephony.—Reiss invented a laboratory telephone in 1861, but nothing practical came of it. In 1876 and 1877 Bell perfected his marvellous instrument, and since then Dolbear and many others have worked at the subject and devised modifications. The number of contrivances now known to be competent to transmit human speech is considerable, and the crude simplicity of some is extraordinary. Hughes has provided the telephone with a more powerful transmitter in the form of a microphone, and Edison has invented a receiver capable of making itself audible to a roomful of persons at once, though with articulation less perfect than that of Bell's instrument.

In 1873 the curious sensitiveness of selenium to light was observed, a fact which received its first practical application in the photophone (1880).

Several attempts are now being made to transmit views or pictures to a distance by electricity, but hitherto without much success, though it has been amply shown to be theoretically possible.

CLASS 70. ELECTRIC LIGHTING APPARATUS.—The one great and undeniable step toward electric lighting has been the invention of the incandescent lamp, in 1877, by Swan & Edison. For the rest, the varieties of arc-lamp and the devices for regulating it are innumerable. Also are the switches, cut-outs, and other secondary but indispensable accessories to safe and effective electric distribution.

The uses possible to the electric light are already very numerous, and may be expected to grow as time goes on. One interesting application is to the lighting of trains, the current being obtained from secondary batteries which are charged by a dynamo driven from the axle of the guard's van, thus utilising the power of the engine for light as well as for locomotion. The six or seven horse power thus consumed seems to make no appreciable difference to the splendid 600 horse locomotives now in use.

Improvements in incandescent lamps may be looked for in the direction of still further improving the vacuum, and avoiding the evaporation of carbon; thus enabling a lamp to be worked at high efficiency without undue shortness of life.

CLASS 71. ELECTRO-METALLURGY AND ELECTRO-CHEMISTRY.—Many improvements in detail have been made in electro-plating, and several processes of photo-electro-typing have been

invented. Clamond piles and "unipolar" or other low resistance dynamos are replacing Smee and Daniell batteries as the source of current. Nickel and other more difficult metals can now be deposited, and articles so coated are becoming largely used.

CLASS 72. DISTRIBUTION AND UTILISATION OF POWER.—Of this department the future growth may be expected to be gigantic, but it is at present in extreme infancy. In 1878 Dr. Siemens made the suggestion which revived activity in the matter of electric motors (machines driven by electric current), and excited the hope that before long the waste water-power of the hill country might be transmitted by wire and utilised in the towns, to the great benefit of the atmosphere of these places, and to the prolongation of the existence of our coal-beds.

An electric railway was constructed at Berlin by one of the firms of Siemens in 1879 and has been running since. Outside the Paris 1881 Exhibition a tramcar was electrically propelled by the same firms, and more recently they have constructed from Portrush to Bushmills a regular passenger electric railway, which derives its power in the most interesting possible manner from a waterfall in the neighbourhood.

In 1882, during the Munich Exhibition, Despretz transmitted a half-horse-power to a town forty miles off by means of a common telegraph wire. An electric boat was run on the Danube at the Vienna Exhibition, in 1883, by the Electrical Storage Co. New devices for electric trams, boats, and tricycles, are constantly appearing. A variety of motors also have been devised. The Siemens dynamo is mostly used for this purpose, but modified dynamos have been constructed for use as motors by De Meritens, Ayrton & Perry, Reckenzaun, and others. The remarkable idea of conveying goods by telegraph has occurred to Fleeming Jenkin, who, with Ayrton & Perry, is endeavouring to found a system of "telpherage"; and, in short, the whole department of transmission of power is lively and active.

CLASS 73. ELECTRIC SIGNALLING.—This class must contain rather a heterogeneous collection of inventions. In the period since 1860 electric chronographs have been perfected, and utilised in the regular transit observations of an astronomical observatory. Siemens' pyrometer of 1875 gave the means of ascertaining distant temperatures; and precisely the same principle has been applied by Langley to the detection of very faint differences of temperature in his "bolometer" of 1881. Under this head also we may mention Edison's "tasimeter," and Hughes's induction balance. Electrical registration is now used in meteorology, and will probably enable mountain tops and other more or less uninhabitable places to be utilised for meteorological stations in the same sort of way, though with less personal exertion and sacrifice, as Ben Nevis is already utilised.

CLASS 74. LIGHTNING CONDUCTORS.—In 1860 Thomson invented a water-dropping collector for the investigation of atmospheric electricity. It is now in regular use at Kew Observatory, and much information may be expected from its continuous record.

In lightning conductors proper, the only progress to be recorded is a gradual but slow improvement in the mode in which they are set up by builders. Insulation is less attended to, and thorough uninsulation more. Gradually the truth will force itself into "practical" minds that every mass of metal in a building should be as directly and thoroughly connected to earth as possible, and that insulation of every kind in a lightning protector is absurd.

A scientific belief in that rare and remarkable phenomenon known as "ball" or "globe" lightning has grown up in recent years, but no means of protection against it has yet been devised. Till this year, in fact, it had never been reproduced in a laboratory, and consequently nothing is known about it; but Planté is now said to have artificially produced it, and if this be the case, our knowledge of it may be expected to grow rapidly.

CLASS 75. ELECTRO-MEDICAL APPARATUS.—The most noteworthy invention in this department has been Graham Bell's application of Hughes's induction balance for the localisation of a bullet in a human body without the use of a probe. It so happens that the present writer had been working in exactly the same direction for six months previously, and had succeeded in getting good indications at a depth of some three inches, but found the difficulties rapidly increase when the possible depth of the bullet or needle, or whatever foreign metal was suspected, was as great as four or five inches.

Among other contrivances may be mentioned the use of small incandescent lamps for illuminating body cavities, and the use of galvanic cautery for minor operations.

CLASS 76. ELECTROLYTIC METHODS FOR EXTRACTING AND PURIFYING METALS.—The

laborious Pattinson process for extracting silver from lead has been superseded by the zinc process. Several metals can now be obtained in a pure state by means of electrolysis.

CLASS 77. ELECTO-THERMIC APPARATUS.—The invention of Abel's fuse has rendered blasting by electricity a still more certain and easy operation than it had formerly been. Search lights and many other applications of electricity to the purposes of war have been made, but it is probable that under the influence of a sufficient stimulus very much more progress in this direction might be made, and war might be rendered so deadly that civilised nations would be almost compelled to confine themselves to diplomacy and arbitration.

PROGRESS IN THE PURE SCIENCE.

Among all the inventions of the past twenty-five years the most striking are no doubt the dynamo and the telephone. The fundamental principle of neither instrument is new—both depend on electrical facts discovered by Faraday—and in both does a single scientific idea receive remarkable practical development, though in different directions.

The dynamo raises the magneto-electric currents of Faraday to engineering magnitude, while the telephone utilises the rapid intermittence of currents almost too feeble to be otherwise detected.

It behoves us then, even in an Exhibition of Inventions, not to omit to notice, though it be with exceeding curtness, the main conquests which have been made in the pure science of electricity during the past twenty-five years.

The great book of Clerk Maxwell was published in 1873. The meaning of the curious experiment of Faraday on a connection between light and magnetism has been read by Thomson and by Maxwell, and has been extended by Kerr, Kundt and Röntgen, Hall, FitzGerald, Rowland, and others.

In 1865 one gigantic stride was made, and Electricity annexed at one swoop the whole of the rich and fertile domain of Optics, thus becoming an imperial science. Such a generalisation as this, giving us for the first time a real theory of light no longer based on analogy with sound—this, and some other less certain but not less remarkable speculations, thrown out and grappled with by the great modern school of physicists, will for ever mark the latter half of this century, as Newton has marked the 17th, Laplace the 18th, and Faraday the earlier half of the 19th centuries.

It is even being said, and said with some truth, that we are beginning at length to know what electricity is. The gigantic importance of such a step as this, when really and thoroughly made, cannot be over-estimated. Chemistry will spring into new life, the great problem of gravitation may be solved, the key even to the constitution of matter may be found, and the ether will take its rightful place, no longer a vague and uncertain hypothesis but the one physical entity of absorbing interest.

University College, Liverpool, March 3rd, 1885.

THE SCHOOL OF ELECTRICAL ENGINEERING AND SUBMARINE TELEGRAPHY, ESTABLISHED IN 1868.

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The PRACTICAL portion of the course includes tuition and daily practice in the various *Systems of Telegraphy*, and especially in **SUBMARINE TELEGRAPHY** with the aid of very large artificial cables and a "Siphon-recorder;" as well as in the different **TELEPHONIC Systems**; also in the different *Methods of ELECTRIC LIGHTING*, including the management of *Prime Motors, Accumulators, Arc and Incandescent Lamps, &c.* An extensive and varied collection of apparatus, including several kinds of Dynamo Machines, is used for this.

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GROUP XIII.—ELECTRICITY.**EAST ARCADE.**

[For Railway Signals, see Group V.; for Photographers, see Groups XV. and XXVIII.; for Scientific Apparatus used in Electrical Research, see Group XXVIII.]

1291. CROMPTON, R. E., & CO., Mansion House Buildings, London, E.C.—(1) Successive Improvements in Crompton-Burgin and Crompton-Kapp dynamo machines. (2) Improvements in measuring instruments: as seen in the present Crompton-Kapp potential and current indicators; in arc lamps for direct and alternating currents, and for search lights—in projectors—in methods of laying mains, forming joints, &c., including distributing box. (3) General Improvements in accessories connected with electric lighting and the supply of electricity.

1292. PATERSON & COOPER, 76 Little Britain, London, E.C.—(1) New Phoenix Dynamo. (2) Phoenix, J F & Clarke Bowman arc lamps. (3) Ammeters, Voltmeters, Caralvos Universal Voltmeter. (4) Switches, Safety Junctions, and other Fittings for electric light. (5) Brackets, Pendants, &c. (6) Samples of Electro-deposition of Metals. (7) Electric Motors. (8) Exploders and Keys for mining and for torpedoes. (9) Thompson & Starling's Photometer.

1293. VARLEY ELECTRIC PATENTS PROPRIETORY (THE), Mildmay Park Works, Mildmay Avenue, Ball's Pond, London, N.—(1) Electrical Appliances generally for use in connection with telegraphy and electric lighting, and especially measuring instruments. (2) Primary and Secondary Batteries. (3) Dynamo and Arc and Incandescent Lamps.

1294. WOODHOUSE & RAWSON, 11 Queen Victoria Street, London, E.C.—(1) Incandescent Lamps. (2) Silvering backs of Incandescent Lamps for reflecting purposes. (3) Holders for incandescent lamps. (4) Automatic Magnetic Cut-out for insuring safety of electrical circuits from over-heating. (5) Ammeters and Voltmeters. (6) Switch for incandescent lamps. (7) Branch Lead Switch and Switch Board systems for governing installations. (8) Small Switch for incandescent lamps. (9) Locking Bar for main branch lead switches. (10) Split Terminals. (11) Lock Nut Terminals. (12) Holder for surgical and microscopical lamps, with adjustable resistance. (13) Apparatus for preventing accident through breaking of lamp filament, and extinction of incandescent lamps. (14) Apparatus for showing ringing of electric bells at the push. (15) Improvements in electric bells. (16) Incandescent Lamps for surgical and microscopical purposes.

1296. EDISON & SWAN UNITED ELECTRIC CO., Limited, 57 Hol-

born Viaduct, London, E.C.—Dynamo Machine.

1297. SMITH, T. TAYLOR, Bush Hill Park, Enfield.—Electric Lighting Apparatus.

1299. FERGUSSON, H. A., 81 Lombard Street, London, E.C.—(1) Electric Bells. (2) Motors. (3) Sewing Machines. (4) Lathes. (5) Railway Signals and Brakes. (6) Electric Lamps. (7) Improvements in Galvanic Batteries.

1300. WARDEN, A. W., 18 Wolsey Road, Mildmay Park, London, N.—Galvanic Batteries.

1301. COXETER, J., & SON, 23 & 24 Grafton Street East, Tottenham Court Road, London, W.C.—(1) Voltaic Batteries [Medical]. (2) Faradaic Batteries. (3) Combined Batteries. (4) Large Quantity Batteries. (5) Electric Bath and Fittings. (6) Electrodes. (7) Electrolysis Instruments. (8) Caustic Battery. (9) Instruments for galvano-plastic operations. (10) Obstetric Vade-Mecum. (11) Aspirators. (12) Oxyhydrogen Lamp. (13) Nasal Speculum. (14) Aural Polypus Forceps. (15) Liquid Nitrous Oxide Gas and Apparatus.

1302. CORDNER, ALLEN, & CO., Limited, 20 Bucklersbury, London, E.C.; and Stanhope Works, Wandsworth Bridge Wharf, Fulham, London, S.W.—Arc Lamp.

1303. WHITING, H. G., 11 Poultry Chambers, Cheapside, London, E.C.—Electric Apparatus and Magnetic Appliances for the prevention and cure of a variety of diseases.

1304. SHEPHERD, C., 2 Alexandra Road, London, N.W.—A Continuous Motion Electrical Turret Clock, striking the hours and quarters by electricity. The batteries for both going and striking will continue in action for two years.

1305. ELECTRICAL POWER STORAGE CO. (THE), 4 Great Winchester Street, London, E.C.—(1) Secondary Batteries of several types for lighting and motive power. (2) Main Distributing Switch Boards and Switches. (3) Motors. (4) Model Electrical Tramcar. (5) Measuring Instruments, &c.

1306. SARNEY, T. S., 13 Ablett Street, Ilderton Road, South Bermondsey, London, S.E.—Improvements in Secondary or Storage Batteries.

1307. SCHOOL OF ELECTRICAL ENGINEERING (THE) & THE PRIMARY BATTERY CO., Limited, 12 Princes Street, Hanover Square, London, W.—Primary Batteries: their application to transmission of power, telegraphy, telephony, and home-to-home lighting by electricity.

1308. ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION, Limited, 112 Belvedere Road, Lambeth, London, S.E.—Improvements in Holders for incandescent lamps and other electrical fittings, in the construction of electric switches, in manufacture of carbons for incandescent electric lamps, in arc electric lamps, in the construction of armatures for dynamo electric machines, in electric generators and motors, in dynamos, armatures for electric current generating machines, and projector.

1309. LYTE, F. MAXWELL, Cotford, Putney, London, S.W.—Primary Batteries: their application to transmission of power, telegraphy, telephony, and home-to-home lighting by electricity in a constant, economical, durable, and portable form.

1310. SENNETT, A. R., & CO., 62 Hatton Garden, London, E.C.—(1) Patent Dynamo-Electric Machine. (2) Patent Electric Lamp. (3) Patent Electrical Accumulator. (4) Electric Lighting Apparatus and Fittings. (5) Patent Primary Batteries. (6) Galvanometers. (7) Dynamometers. (8) Patent Electroplating Apparatus. (9) Patent Electro Blocks.

1311. GULCHER ELECTRIC LIGHT & POWER CO., Limited (THE), 4 Coleman Street, London, E.C.—Electrical Transmission of Power.

1312. D'HUMY, F., 2 Carlton Mansions, Clapham Rise, London, S.W.—Primary Battery.

1313. HENLEY'S, W. T., TELEGRAPH WORKS COMPANY, Limited, 8 Drapers' Gardens, London, E.C.; and North Woolwich.—(1) Patent Ozokerited Core. (2) Core and Cables for telegraph, telephone, and electric light. (3) Henley's Patent Wrought and Cast Iron Troughing for underground conductors.

1314. CALLENDER'S BITUMEN TELEGRAPH AND WATERPROOF CO., Limited, 101 Leadenhall Street, London, E.C.—Patent Compound for insulating telegraph and other electrical conductors, and for waterproofing cloth or canvas.

1315. COXETER & NEHMER, 23 & 24 Grafton Street East, Tottenham Court Road, London, W.C.—(1) Improvements in Motors and Electric Generators. (2) Dwarf Water-wheel Dynamos. (3) Electric Engine. (4) Electric Dental Mallet. (5) Colossal Batteries of Silico-Carbon. (6) Pocket Electric Gas Lighter. (7) Silico-Carbon Accumulators. (8) Universal Safety Incandescence Electric Lamp Holder. (9) Pocket Voltaic Batteries.

1316. UNITED TELEPHONE CO., Oxford Court, Cannon Street, London, E.C.—Telephonic Apparatus.

1317. SMITH, A., & STEVENS, 48 Leicester Square, London, W.C.—(1)

Portable Combined Electric Bell and Battery. (2) Vertical Action Electric Indicator.

1318. CONSOLIDATED ELECTRIC CO., Limited, 68a Cow Cross Street, London, E.C.—The B. T. K. System of Electric Lighting from Storage Batteries, and of Distribution of Electricity from a Central Station for house-to-house lighting.

1319. COOKE, G. K., Mfg. CO., 74 & 75 Cow Cross Street, London, E.C.—Improvements in Galvanic Batteries.

1320. BERNSTEIN ELECTRIC LAMP CO., Mansion House Buildings, 4 Queen Victoria Street, London, E.C.—Bernstein Electric Incandescent Lamp.

1321. PHILLIPS, F. C., 2 Victoria Mansions, Westminster, London, S.W.—(1) Arc Lamp, ordinary form; and also special form for chemical works. (2) Dynamo Electric Machine. (3) Electrical Measuring Instruments, for measuring current and electromotive force.

1322. ELECTRIC APPARATUS CO. Limited, 58 Queen Victoria Street, London, E.C.—(1) Loud Speaking Telephones. (2) Electric Motors. (3) Thermo Electric Batteries. (4) Primary Battery.

1323. MACDONALD, JOHN H. A., 15 Abercromby Place, Edinburgh.—Electric Holophote Ship's Course Indicator, for the prevention of collision at sea.

1324. FORBES, PROF. GEORGE, 34 Great George Street, Westminster, London, S.W.—Dynamo Electric Machine for electro-plating, for refining metals instead of by smelting processes, and for central station lighting. They also work as powerful motors.

1325. MACKENZIE & BROUGHAN, 15 Great George Street, Westminster, London, S.W.—(1) Electric Apparatus for firing heavy ordnance, torpedoes, blasting, &c. (2) Microphones and Telephonic Apparatus and Electric Light Fittings.

1326. SWAN, J. W., Bromley, Kent.—(1) The Swan Lamp, various types and uses. (2) A New Process for production of perfect uniform carbon filaments for electric lamp. (3) Meters for integrating time and current adapted for electric lighting. (4) Secondary Battery, with cellular plates for holding active material. (5) Non-combustible Safety Catch with tin fuses. (6) Improved Switches. (7) Illustration of a simple method of laying electric mains.

1327. LAING, WHARTON, DOWN, 8, 9 Holborn Viaduct, London, E.C.—(1) Dynamo Electric Generators. (2) Automatic Current Regulators. (3) Arc Lamp. (4) Switches, Cut-offs. (5) Incandescent Lamp Distributors. (6) Central Station Switch Boards, &c. (7) Improvements and Novelty in Switches, Lamp Holders, Safety Cut-off

Shades, Reflectors and other fittings for incandescent lighting.

1328. **JOEL, HENRY FRANCIS**, Power Chambers, Moorgate Street, London, E.C.—(1) Pneumatic Signalling Apparatus, Bells, &c. (2) Magneto-Electric Machines and Electric Light Apparatus. (3) Electric Lamps. (4) Apparatus for accommodating electrical conductors in streets. (5) Secondary Batteries. (6) Electric Current Measurer. (7) Electric Arc Lamps. (8) Secondary Voltaic Batteries.

1329. **LEA, JOHN, & G. C. HARVEY**, Great St. Helens, Bishopsgate Street, London, E.C.—An Improved Method or means for effecting registration of marine compasses at a distance.

1330. **MILLER, LESLIE B.**, 82 Hatfield Garden, London, E.C.—(1) Electro-meters. (2) Electric Meters.

1331. **OPPERMANN, E.**, 55 Spencer Street, London, E.C.—(1) Improvements in relating to galvanic batteries. (2) Speed of Charging Governor.

1332. **RICHMOND, WILLIAM PHENSON**, 31 Stanwick Road, Kensington, London, W.—Automatic Fire Alarm.

1333. **KENDALL, J. A.**, Middlesbrough, Yorkshire. — Electric Generator. An exhibit illustrates the experimental development of a method by which the energy of combustion of fuel can be directly converted into electric energy, thus giving a source of electric power, light, &c. The conversion is effected by the intervention of hydrogen.

1335. **IMMISCH, M.**, Electric Works, Wand Road, Prince of Wales Road, London, N.W. — Electro - Motors and Dynamos.

1336. **VARLEY, S. A.**, 2 Hamilton Road, Highbury, London, N.—(1) The Dynamo-Electric Machine constructed, in which the field magnets were made entirely of iron. (2) Undemagnetizable Needle Telegraph Coils, adopted by Postal Telegraph Department and lightning bridges.

1337. **HOWARD, F. GEERE**, Cleveland Works, Cleveland Street, Fitzroy Square, London, W.—(1) Patent Frames Electrodes for secondary batteries. (2) Insulated Wood Cells for secondary and primary batteries. (3) Secondary Batteries. (4) Primary Batteries. (5) Casings and Bindings for cables and wires, &c., &c.

1338. **WALKER, FREDERICK**, 36 London Road, Tottenham, Middlesex. — Electrical Energy Recording Apparatus, to be used either as a measuring instrument for electrical testing in the laboratory, or as a current or energy meter in an electric light or power circuit.

1339. **GLOBE ELECTRICAL AND ENGINEERING COMPANY (THE)**, 20 Dartmouth Street, Westminster, London, S.W.—(1) Killingworth Hedges' Patented Improvements in Speed Indicators for dynamos, switches, commutators, rheostats. (2) Fusible Safety Plugs with mica foils. (3) Fusible Circuit Breaker for telegraph and telephone protection. (4) Consolidated Carbon Rods and Battery Plates.

1340. **MARCH, OCTAVIUS**, 53 Graton Road, West Kensington Park, London, W.—(1) Improvements in Electro-Motors. (2) Holmes Burke Patent Primary Batteries. (3) Improvements in instruments for measuring electro-metre force and currents. (4) Improvements in holders and fittings for incandescent lamps. (5) Improvements in terminal binding screws and connections for wire cable and other electric conductors.

1341. **ROSE, A. V. & G. F.**, 26 Cavendish Road, Brondesbury, and Penrose House, Hampstead, London, N.W. — Portable Electric Lamps.

1342. **RILEY, JOHN**, Riddings, Alfreton, Derbyshire.—Magneto or Dynamo-Electric Machine.

1343. **WHITFIELD, CHARLES**, Kettering, Northamptonshire. — Improvements in Galvanic Batteries.

1344. **WADLEY BROTHERS**, 78 Lower Sloane Street, London, S.W.—Dynamo-Electric Machine.

1345. **DALE, H. & E. J.**, 26 Ludgate Hill, London, E.C.—(1) Primary Battery. (2) Alarms and Bell. (3) Lightning Conductors. (4) Medical Apparatus. (5) Electrical Contact Thermometers, metallic and mercurial. (6) Cross' Patent Bolts for doors. (7) Electric Alarm Clocks.

1346. **LUNDBERG, ANDRÉ PETER**, 1a Bowling Green Lane Buildings, Farringdon Road, London, E.C.—(1) Electric Arc Lamps. (2) Different Electric Light Switches. (3) Incandescent Electric Lampholders of various patterns. (4) Dynamo Machines. (5) Surveyor's Level. (6) Fish Bolt. (7) Universal Spanner.

1347. **MACKIE, W.**, Turk's Head Yard, Turnmill Street, London, E.C.—(1) Primary Battery. (2) Holder for incandescent lamps. (3) Improved Arc Lamp. (4) Fusible Plug. (5) Electrical Apparatus. (6) Incandescent Lamps.

1348. **CANNELL, CHARLES**, Thorpe Asylum, Norwich.—(1) Dynamo Machine. (2) Electrical Tell-tale.

1349. **FOX, EDWIN, & CO., Limited**, Magnetic Telegraph Wire Works, Millwall, London, E.—Improvements in galvanizing or covering wire with zinc, tin, copper, brass, nickel, &c.

1350. HUTH, A. H., Bolney House, Ennismore Gardens, London, S.W.—Improvements in the manufacture of india-rubber and gutta-percha, eliminating metallic salts.

1351. KINETIC ENGINEERING COMPANY (THE), 36 & 37 Brooke Street, Holborn, London, E.C.—Berthoud-Borel System of Electric Cables.

1352. MEYER, H. R., 314 Exchange Buildings, Liverpool.—Sections of Patent Underground Electric Light and Telegraph or Telephone Mains.

1353. SHIPPEY BROTHERS, 13 & 14 King Street, Cheapside, London, E.C.—Patent Incandescent Lamps.

1354. REDDALL, WILLIAM, 10 South Street, Finsbury, London, E.C.—Patent Box Street Curb, for the conveyance of electric wires through the streets of cities and towns and elsewhere.

1355. SELLARS, J. C., 27 Canning Street, and 68 Bridge Street, Birkenhead.—Improved modes of laying and insulating electric telegraph and telephone wires and electric light and power wires underground and along the faces of buildings; also improved cables for laying underground, underwater, or elsewhere.

1356. THOMPSON, DOWSING, & REW, 4 Queen Victoria Street, London, E.C.—Electric Light and Battery Carbons.

1357. PARKES, ALEXANDER, 32 Park Road, West Dulwich, London, S.E.—Improvements in the manufacture of compounds of india-rubber and gutta-percha, and oils for insulating electrical conductors, and in varnish for preserving iron or other ships, and for other purposes.

1358. AYRTON & PERRY, PROFESSIONERS—(1) Instruments employed in electrical measurement. (2) Magnifying Spring and other Ammeters. (3) Voltmeter. (4) Ohmmeters. (5) Power Meters. (6) Ergmeters and Coulombmeters. (7) Photometers. (8) Dynamometer Coupling. (9) Transmission Dynamometer. (10) Electro Motors. (11) Weighing Machine.

1359. IRISH, W. E., Electric Works, Sunderland.—(1) Speech Recorder or Telephonograph. (2) Telephonic Apparatus. (3) Magneto Electric Generator and Bell. (4) Polarised Double-tongued Relay. (5) Portable Electric Bell. (6) Improved Call for telephonic and other purposes. (7) Arc Electric Lamp.

1360. STEPHEN, J., Ravelston Cottage, Blackhall, Mid Lothian, N.B.—(1) Fire Call. (2) Telephonic Apparatus. (3) Individual Call for telephone, telegraph, &c. (4) Telephone Receiver. (5) Harmonic Engine. (6) Domestic Telegraph.

1361. TROUVÉ, G., Paris (care of J. F. AYLMEER, Leadenhall Buildings, London, E.C.).—(1) Batteries. (2) Military Telegraph. (3) Electric Motor. (4) Electric Boats. (5) Electric Tricycle.

1362. HARRISON, COX-WALKER & CO., 15 Blackwellgate, Darlington.—(1) Cox-Walker's Electric Tell Tale. (2) Electric Water Level Indicator. (3) Electric Motor. (4) Electric Fire Alarm Appliances and Gong. (5) Electric Semaphores. (6) Telephonic Instruments. (7) Cox-Walker's Patent Lampholders for Incandescent Lamps. (8) Dentist's Lampholder and Switch for Incandescent Lamps. (9) Electric Dome of Stud Bells. (10) Electric Railway Miniature Signal Bells, Relay and Tappers. (11) Magnetor Generator, with writing desk, dome of bell and automatic switch for telephones. (12) Linthorpe Ware Electric Pushes. (13) Electric Dinner Gong.

1363. HUMM, MOSES, 727 Commercial Road, London, E.—Improvements in Electric Baths.

1364. GRAY, J. W., & SON, 115 Leadenhall Street, London, E.C.—Gray's Patent System of Lightning Conductors and instruments for testing same.

1366. MUNRO, JOHN, 2 Somerset Villas, West Croydon.—Telephonic Apparatus.

1367. STRANGEWAYS, H. B. T., Pump Court, Temple, London, E.C.—Clear and Loud Speaking Long Distance Telephone.

1369. WATERS, S., 24 Ladbrook Square, London, W.—Improvements in Electric Lamps by converting a part of the globe into a reflector and so economising light.

1370. BAGOT, A. C., 42 Lower Street, London, S.W.—(1) Safety Indicator for mines, ships, frozen meat chambers, breweries, and cotton stores, to give warning of heat and cold, and variations of atmospheric pressures at any distance automatically. (2) Improvements in Mining Signals, Gongs, &c. to ensure block signalling, to prevent winding and hauling plane accidents, and to prevent collision between the men, whilst enabling them to work with greater safety and at greater speed.

1371. MOXON, JAMES G., 24 Great Avenue, Leadenhall Market, London, E.C.—Moxon's Improved Letter Box with Signal and Protector. Before a letter or other article is deposited in this letter box a signal is given; and when there cannot be surreptitious abstraction.

1372. FERRIS, HENRY W., 9 Dorset Road, Merton, Surrey.—Improved Portable Electric Alarm Mat and Connecting Gear for shop-doors, warehouse and office entrances, stairs, &c.

1373. **PERRY, A. H., 6 Friends Road, Croydon.**—Improvements in Railway signalling Apparatus, for protecting the lives of men working in tunnels.

1375. **HOLMES, J. H., & CO., 67 Westgate Road, Newcastle-on-Tyne.**—Holmes's Patent Instantaneous Break electric Light Switches, for preventing the formation of dangerous arcs on breaking an electric circuit. (2) Holmes's Cut-outs or Safety switches on incombustible bases of porcelain, &c. (3) Electric Lamp Holders and other fittings.

1376. **RICHARDSON, G., & WILLIAM RAWORTH, 39 Nursery Road, Eton, London, S.W.**—Improvements in Movable Key Switches for electric lighting for other purposes.

1377. **STEWART, CHARLES W., 41 Albion Street, Albany Road, Camberwell, London, S.E.**—Electric Indicators.

1378. **ROGERS, FRANCIS M., 21 Albany Pavement, London, E.C.**—(1) Railway Station Indicator, for showing in the station arrived at. (2) Fire and Alarm. (3) Self-acting Arc Electric Lamp. (4) Needle Sounder. (5) Electrical Vane, for showing within the house the direction of wind.

1379. **TROTT, H., & FENTON, 75 Chancery Street, Battersea, London, S.W.**—Electric Arc Lamps. (2) Electric Bells.

1380. **SWAN, ALFRED, Low Fell, Warrington-on-Tyne.**—Improvements in the manufacture of fittings for incandescent electric lamps, comprising holders, switches, cut-outs, &c., illustrating the capabilities and advantages of the new material vitrite for all fittings.

1381. **ADAMS, J. H., 34 Fullerton Road, Wandsworth, London, S.W.**—Improved Electro-Motor with double armature.

1382. **BAYLEY & SON, Poole, Dorset.**—Bayley Electric Clutch Motor, which is self-starting at full power in any position and self-regulating.

1383. **THORPE, H., 59 Theobald's Road, London, W.C.**—(1) Patent Electric Light Indicator. (2) Improved Semi-circular Pendulum Indicator, entirely new form. (3) Continuous Arrangement for ringing any number of bells continuously. (4) Magneto Sounder. (5) Telephone Switch Apparatus.

1384. **GANT, ROBERT B., 39 Artillery Place, Woolwich.**—Electro Motor.

1385. **BROWN, A. C., 11 Old Broad Street, London, E.C.**—(1) Fire Alarm [electric]. (2) Fire Alarm Telegraph. (3) Telephone Signal or Individual Call.

1386. **SMITH, C., 1 Queen Victoria Street, Mansion House, London, E.C.**—

Electric Light Speculum and Microscope Clip Lamp.

1389. **FRASER, GENERAL R. MACLEOD, 27 Dorset Square, London, N.W.**—Double Action Electric Motor, no dead points.

1390. **LOBB, HARRY, Surgeon, 66 Russell Square, London, W.C.**—(1) Electro-Magnetic Battery. (2) Constant Voltaic Battery. (3) Conductors for Medical Electrization.

1391. **CROOKES, WILLIAM, 7 Kensington Park Gardens, London, W.**—(1) Apparatus and materials illustrating the various processes in the manufacture of incandescent electric lamps. (2) Radiometers, Otheoscopes, and Photometers. (3) Apparatus illustrating repulsion resulting from radiation. (4) Vacuum Torsion Balance. (5) Tubes illustrating molecular physics in high vacua. (6) The Illumination of Lamps of Molecular Pressure and the Trajectory of Molecules. (7) Phosphorogenic Properties of the Molecular Discharge *in vacuo*. (8) Phosphorescence of the Diamond Ruby, Phenakite, &c. (9) Radiant Matter Spectroscopy. (10) Detection and Wide Distribution of Yttrium, &c. (11) The Samarskite Earths. (12) Thorina Vacuum. (13) Thallium.

1392. **GERARD & CO., Limited, 82 Hatton Garden, London, E.C.**—Electrical Apparatus.

1393. **ALDRIDGE, J. G. W., 2 Clyde Terrace, Bevers Hill, Southampton.**—Incandescent Lamp, not requiring a vacuum.

1394. **DAVIS & TIMMINS, Limited, Bowling Green Lane, Farringdon Road, London, E.C.**—(1) Screws and turned parts used for electrical, telephonic, and mathematical and philosophic purposes. (2) High Conductivity Copper Wire. (3) Straight-drawn Brass, Iron, and Steel.

1395. **FARADAY & SON, 3 Berners Street, Oxford Street, London, W.**—(1) Electric Light Fittings for glow lamps. (2) Electroliters. (3) Switches. (4) Lamp Holders. (5) Wire Connectors. (6) Shades and Reflectors. (7) Decorative Fittings.

1397. **VULCAN MANUFACTURING CO., Vulcan Works, Rochiffe Street, Islington, London, N.**—(1) Patent Electric Bells and Signals for domestic, public, and ship's purposes. (2) Ferro-manganese Batteries for signal work.

1398. **BRAILS福德, T. R., Thames Conservancy Office, 41 Trinity Square, Tower Hill, London, E.C.**—(1) Electrical Tide Gauge and Register. (2) Electrical Rain Gauge and Register.

1399. **BOTTEN, HENRY, 39 Lime Street, London, E.C.**—Signal Indicator Apparatus for engine-room telegraphs, and for indicating names of railway stations in the car-

riages; for time recorders, also for indicating on platforms and in booking offices the times of departure and destination of trains, and for various other purposes.

1400. NEW TELEPHONE CO., Limited, 4 Great Winchester Street, London, E.C.—Valve Telephones manufactured under the patents of Professor Silvanus P. Thompson of University College, Bristol.

1401. LORRAIN, J. G., 3 Vernon Chambers, Southampton Row, W.C.—(1) Patent System of manufacturing Carbon Filaments, Rods, &c., for electric lighting. (2) Improvement in Incandescent Electric Lamps. (3) Patent Pivot Electric Arc Lamp. (4) Patent Slide Electric Arc Lamp. (5) Patent System of Telephony. (6) Improved Globes for Incandescent Electric Lamps.

1403. BRITISH AND FOREIGN MARINE INVENTIONS COMPANY, Limited (THE), 2 Threadneedle Street, London, E.C.—(1) Balch's Apparatus for sounding at sea by electricity. (2) Barnes and Heath's Apparatus for indicating and signalling the depth of water, for use in ships. (3) Rocket Signal Tube and Signal Shell. (4) Improved Life Buoy, fitted with signals and shark guard.

1404. DANCHELL, F. H., C.E., 47 Tunbridge Road, Maidstone.—Electric Railway.

1405. TRAILL, WILLIAM A., Giant's Causeway Electric Tramway, Portrush, Co. Antrim.—(1) Model of Giant's Causeway Electric Tramway, adapted for railways, road, and street tramways. (2) Electric Brushes or Collectors for electric railways and tramways.

1406. JACK, JAMES H., Viewforth Park, Edinburgh.—Self-indicating Target.

1407. JABLOCHKOFF & GENERAL ELECTRICITY CO., Limited, (THE), 36 Albert Embankment, Lambeth, London, S.E.—(1) Patent Electric Candles. (2) Electric Arc Lamps. (3) Switches and Fittings for arc and incandescent lighting.

1408. HARDTMUTH, F., & CO., 2 Long Lane, London, E.C. (Works: Vienna, Austria).—Electric Carbons.

1409. PRESTOPINO, J., 42 Great Percy Street, Pentonville, London, N.—Dr. Garau's Railway Electric Alarm Bell.

1412. STUART & CO., 8 Thomas Street, Edinburgh; and Granolithic Wharf, Church Row, Limehouse, London, E.—Section of Granolithic Pavement showing conduits underneath for telegraph, telephone, and electric light wires.

1413. JENKIN, F., 3 Great Stuart Street, Edinburgh; and 53 Old Broad Street, London, E.C.—(1) Telpherage, a

system of electrical automatic transport by aerial lines. (2) Suspended Insulated Locomotive and Truck Inter-governor and Break. (3) Blocking Arrangements. (4) Working Model.

1414. BAKER, H. G., 3 Upper East Smithfield, London, E.—Hemp Covering for the core of a submarine cable.

1415. ROUSSY, EMILE LOUIS Vevey, Switzerland (Agents, BAUER & CO., 8 Union Court, London, E.C.).—Improved Incandescent Light Moderator.

STANDARD ELECTRIC MANUFACTURING CO., 84 Broad Street, New York, U.S.A.—(1) The Delany Synchronous Multiplex Telegraph System. Twelve, or seventy-two messages transmitted over a single wire at the same time. (2) Facsimile transmission. Printing and Manuscript Systems worked simultaneously.

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BLAKESLEY, T. H., 25 Queen Anne's Gate, London, S.W. (See Group XXVIII.)

CAINK, THOMAS, 2 Westbourne Terrace, Malvern Link, Worcestershire. (See Group XV.)

CAMBRIDGE SCIENTIFIC INSTRUMENT CO. (THE), St. Tibbs Row, Cambridge. (See Group XXVIII.)

CANNELL, CHARLES, Thorpe Asylum, Norwich. (See Group IV.)

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CUSWORTH, C., 30 Ellington Street, London, N. (See Group XXIX.)

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EASTON & ANDERSON, 3 Whitehall Place, London, S.W. (*See Group III.*)

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ELECTRIC SIGNAL CO., Limited, 2 Hogarth Road, West Kensington, London, S.W. (*See Group V.*)

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MEEZE, ARTHUR G., Redhill, Surrey. (*See Group XXVIII.*)

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APPARATUS, PROCESSES AND APPLIANCES CONNECTED WITH APPLIED CHEMISTRY AND PHYSICS.

BY PROFESSOR HENRY E. ARMSTRONG, Ph.D., F.R.S.

THOUGH it would be impossible in the space at my disposal even to refer to all the various discoveries and inventions included under this heading, it is not difficult to frame a brief account showing the more important applications of chemical science to industry that have been achieved during the last twenty years or so, as we possess in the well-known "Report on Chemical Products and Processes," at the 1862 Exhibition, by Prof. Hofmann, D.C.L., F.R.S., a masterly record of the chemical industries at that time existent.

THE ALKALI TRADE.

Sodium Carbonate—Washing Soda.—The opening passage of the section headed "Carbonate of Sodium" in Hofmann's Report is as follows:—"The ever-memorable discovery by the illustrious Leblanc of the process now everywhere in use for manufacturing carbonate of sodium from common salt stands distinguished in the annals of industry, not only as by far the most important of all chemico-industrial inventions, but also (a signal fact) as having been created perfect. All the other great chemical industries have been slowly worked out by the toil of successive inventors; but Leblanc's process, the greatest of all, remains to this day what it was when he first gave it to the world, the best and simplest method of effecting the most valuable of all known transformations. Though eighty-six years have elapsed since this splendid discovery was made, and innumerable researches have been undertaken with a view to its improvement, the original indications of Leblanc are all but universally followed, with merely a comparatively unimportant modifications."

The Leblanc process, however, now no longer maintains its proud supremacy, in consequence of the introduction of the Ammonia-soda process. Leblanc soda is made by treating salt with sulphuric acid, thereby producing hydrogen chloride gas and sodium sulphate ($2\text{NaCl} + \text{H}_2\text{SO}_4 = \text{Na}_2\text{SO}_4 + 2\text{HCl}$); the latter is then roasted with coal and chalk, and the sodium sulphate thus deprived of its oxygen by the carbon of the coal, being reduced to sodium sulphide ($\text{Na}_2\text{SO}_4 + 4\text{C} = \text{Na}_2\text{S} + 4\text{CO}$), which then enters into reaction with the chalk, forming calcium sulphide and sodium carbonate ($\text{Na}_2\text{S} + \text{CaCO}_3 = \text{Na}_2\text{CO}_3 + \text{CaS}$). The process therefore involves the uses of sulphuric acid, which is manufactured in enormous quantities for the purpose; and as by-products it furnishes muriatic acid and sulphur waste. A remarkably interesting process for manufacturing sodium sulphate directly from salt and sulphur dioxide without the use of sulphuric acid, that has been introduced by Mr. Hargreaves, should be mentioned here. It consists in heating the salt in kilns or stoves and passing in sulphur dioxide, air and steam in carefully regulated proportions; hydrogen chloride gas is given off, and sodium sulphate remains, as in the ordinary process ($4\text{NaCl} + 2\text{SO}_2 + \text{O}_2 + 2\text{H}_2\text{O} = 2\text{Na}_2\text{SO}_4 + 4\text{HCl}$).

The greater part of the muriatic acid produced as a bye-product in the manufacture of soda is utilised in the manufacture of bleaching powder, the acid being heated with peroxide of manganese and the resulting chlorine then passed over moist slaked lime. A most important change has been made since 1862 in this branch of the alkali maker's operations by the introduction and universal adoption of the *Weldon* process for the regeneration of the peroxide of manganese from the waste liquor from the chlorine stills. This liquor is in the main a solution of manganese chloride produced by the reaction $\text{MnO}_2 + 4\text{HCl} = \text{MnCl}_2 + \text{Cl}_2 + 2\text{H}_2\text{O}$. It is freed from excess of acid and from iron by means of chalk, which neutralises the acid and causes the precipitation of the iron as ferric hydrate; the clarified liquid is then mixed with a certain excess of lime—whereby the manganese is precipitated as the hydroxide $\text{Mn}(\text{OH})_2$, it is heated to about 55°C ., and a rapid current of air is blown into it. Under these conditions—in the

presence of lime and at the temperature mentioned, the manganous hydroxide takes up oxygen and a compound containing lime is formed. After a time, the solid having been allowed to settle, the liquid is drawn off, and the "Weldon mud," as the regenerated peroxide is termed, is run into the chlorine stills, there to be heated with muriatic acid.

A new process for the manufacture of chlorine has been introduced by Mr. Deacon, Widnes, which is not only of great beauty and interest scientifically, but also because hydrogen is withdrawn from its association with chlorine by means of atmospheric oxygen. When a mixture of oxygen and hydrogen chloride gases is strongly heated, chlorine and water are obtained ($4\text{HCl} + \text{O}_2 = 2\text{Cl}_2 + 2\text{H}_2\text{O}$). Mr. Deacon has shown that, if a mixture of air and hydrogen chloride be passed through chambers packed with pieces of firebrick that has been soaked in a solution of copper sulphate and dried, the same chemical change takes place at much lower temperature than that at which oxygen alone acts on hydrogen chloride, the reaction being at its maximum at about 500°C . The copper sulphate is but little affected by a good deal of the hydrogen chloride, however, escapes unchanged, and has to be scrubbed of the gas; and another drawback of the process is that the chlorine is largely diluted with air and nitrogen.

The sulphur-waste of the Leblanc process was referred to above. To use words recently uttered by Mr. Weldon—"Countless have been the efforts to utilise at least one of the constituents of that residue, but none of them have fully succeeded. . . . Now, however, when we cannot but fear that the long day of the Leblanc process may be tending towards its close, means of utilising both the principal constituents of that residue seems almost in sight." Messrs. Schaffner and Helbig, of Aussig, in Bohemia, a few years ago introduced a process for the recovery of the sulphur, which has been carried out in this country with remarkable energy and determination by Mr. Alexander Chance, of Birmingham, and which is of high scientific interest. It consists in heating the fresh waste with solution of magnesium chloride; magnesium sulphide and calcium chloride are thus formed ($\text{CaS} + \text{MgCl}_2 = \text{CaCl}_2 + \text{MgS}$); but the magnesium sulphide, being in presence of water, is at once acted upon, and sulphuretted hydrogen gas and magnesium hydroxide are produced ($\text{MgS} + 2\text{H}_2\text{O} = \text{H}_2\text{S} + \text{Mg}(\text{OH})_2$). The magnesium hydroxide is in suspension in a solution of calcium chloride; on passing carbon dioxide gas through this magma, magnesium chloride and calcium carbonate are formed ($\text{CaCl}_2 + \text{Mg}(\text{OH})_2 + \text{CO}_2 = \text{CaCO}_3 + \text{MgCl}_2 + \text{H}_2\text{O}$); in fact, the magnesium chloride originally used is regenerated, and also is the calcium carbonate originally used in converting the sodium sulphate into carbon disulphide. Messrs. Schaffner and Helbig recovered the sulphur from the sulphuretted hydrogen by burning one-third to sulphur dioxide and water ($2\text{SH}_2 + 3\text{O}_2 = 2\text{SO}_2 + 2\text{H}_2\text{O}$), mixing the products with the remaining two-thirds, and passing the mixture up through a tower down which a solution of calcium chloride was kept trickling. When moist sulphur dioxide and sulphuretted hydrogen are brought together, a complex reaction takes place, pentathionic acid being formed as well as sulphur and water, but in presence of calcium chloride either no pentathionic acid is formed or if any be produced, it is immediately decomposed, and all the sulphur in the two gases is obtained as such. It need scarcely be added that the reactions described take place only under certain special conditions of temperature, concentration, &c.; in fact, such processes to be successful require most careful watching and much skilful supervision. Another method of recovering sulphur from sulphuretted hydrogen consists in partially burning it by mixing with only sufficient air to furnish the oxygen required to convert the hydrogen into water. Mr. Claus has invented a kiln for this purpose, in which the mixture of air and sulphuretted hydrogen is passed through a bed of oxide of iron.

To pass now to the Ammonia-soda process. Briefly stated, this consists in causing carbon dioxide to act upon a solution of common salt in aqueous ammonia; owing, it may be said, to the slight solubility of sodium bicarbonate, this salt and ammonium chloride are formed ($\text{NaCl} + \text{CO}_2 + \text{H}_2\text{O} = \text{HNaCO}_3 + \text{NH}_4\text{Cl}$). By heating the mother liquor with lime or magnesium hydroxide the ammonia is recovered, so that practically the only waste product is calcium or magnesium chloride. Although the process is an old one, having been patented in 1838 by Dyer and Hemming, it was not until 1866 that it was worked on a practical commercial scale with satisfactory results by M. Solvay, of Brussels. Its progress has been most remarkable. In a paper "On the Present Condition of the Soda Industry," read at a meeting of the Society of Chemical Industry in January, 1883, by Mr. Walter Weldon, F.R.S., an authority second to none,

following figures are quoted as showing the total soda production of the world in terms of pure sodium carbonate (Na_2CO_3):—

	Leblanc soda.	Ammonia soda.	Total.	Ammonia soda per cent. of total soda.
Great Britain	380,000	52,000	432,000	12·0
France	70,000	57,125	127,125	44·9
Germany	56,500	44,000	100,500	43·8
Austria	89,000	1,000	40,000	2·5
Belgium	...	8,000	8,000	100·0
United States	...	1,100	1,100	100·0
Total ..	545,500	163,225	708,725	23·0

In July of last year, in his presidential address to the same society, Mr. Weldon said, "The ammonia-soda process has continued its victorious advance, and the production of Leblanc soda has still further diminished . . . Regarded merely as a means of manufacturing soda, it (the Leblanc process) has served its time. Per given quantity of soda yielded by it, it is more than 70 per cent. more costly than the ammonia process; and thus its only claim to continue to live consists in the fact that it yields hydrochloric acid." He further says:—"So far as one can see, the world must continue to be supplied with chlorine. At present the immediate raw material of the chlorine manufacture is always hydrochloric acid, and for our supply of that raw material we are entirely dependent on the Leblanc process. Is this state of things destined to continue? Is the Leblanc process likely to remain our only means of obtaining hydrochloric acid? And, above all, must the production of hydrochloric acid always be, as now, an essential condition precedent of the production of chlorine?"

THE UTILISATION OF COAL.

Coal is used as fuel for domestic purposes and in manufacturing industries, and in the manufacture of coal gas. The introduction of the regenerative furnace in 1861, by the Messrs. Siemens, marks an entirely new departure, and in consequence much attention has been devoted during recent years to the use of gaseous fuel. Apart from the advantages arising from the use of gas as fuel, there is the additional one that it becomes possible to recover from the coal certain constituents which have little or no value as fuel, but which are actually of value themselves, and the removal of which is even desirable on other besides economic grounds, viz., sulphur, nitrogen in the form of ammonia, and tar. Although the subject has recently been much discussed, the advance actually made in this direction is not great. The Scotch ironmasters have proved that it is possible to scrub out from the blast furnace gases both ammonia and tar; the introduction of the Simon-Carvès, the Jameson, and other forms of smoke oven has rendered possible the collection of the volatile products given off in coking coal; but at present little more has been done than to show that it is both possible and profitable to gasify coal and to submit the gaseous product to a preliminary treatment in order to separate certain constituents before actually using it as fuel. Apart from the commercial advantages resulting from the adoption of this course, such a departure from established practice will be of enormous advantage to the general public, as it will involve the abatement of the smoke nuisance, which is fast becoming intolerable.

Although, from the chemist's point of view, no advance whatever has been made in the manufacture of coal gas during the last twenty years, the utilisation of the various constituents of coal tar has progressed in a most marvellous manner: in fact, two, if not three, new industries have been developed. At the time of the 1862 Exhibition, the coal tar colours then known were made almost exclusively from the hydrocarbons, benzene, C_6H_6 , and toluene, C_7H_8 .

Since then it has not only been discovered that the madder-colours are derivatives of the hydrocarbon *anthracene*, $C_{14}H_{10}$, but the way to make them from anthracene has been found out, and they are now manufactured to the extent of several hundred tons per annum from coal tar. A variety of most valuable and beautiful *Azo-dyes* have been made from naphthalene, $C_{10}H_8$, of which coal-tar contains a relatively very considerable proportion. Indigo has been made artificially, and not only in the laboratory: Bayer's astounding and brilliant achievement having been immediately repeated on a manufacturing scale, although, for commercial reasons, artificial indigo has not become a competitor of the natural article. Lastly, Kolbe having discovered an easy method for the preparation of salicylic acid from phenol or carbolic acid, and having also shown that it is a powerful antiseptic, and in many respects a more useful or safer one than phenol itself, the manufacture of salicylic acid from phenol, and, therefore, from coal-tar, has become an industry of some magnitude.

Hofmann, in his report, speaks of the chemical composition of madder as doubtful, and he assigns to alizarin and purpurin, the essential constituents of madder, the formulae given to them by Strecker, viz.:—alizarin = $C_{14}H_6O_4$; purpurin = $C_{14}H_4O_5$. Prior to 1869, madder-root was one of the most important dye-stuffs known, the annual value of the imports into the United Kingdom being about £1,000,000 sterling. The plant was cultivated in Holland, South Germany, France, Italy, Turkey, and India. The attention of Græbe and Liebermann became directed to alizarin in consequence of one of them (Græbe) having been engaged in what may be termed a purely theoretical investigation of a class of compounds known as Quinones: judging from its properties, they thought it probable that alizarin was a quinone derivative of a hydrocarbon, and in order to obtain the hydrocarbon they distilled alizarin with zinc dust. Anthracene, a hydrocarbon discovered in coal tar by Dumas and Laurent in 1832, was the product. This discovery was published early in 1868. They soon succeeded in determining the relation of alizarin and purpurin to anthracene, and showed that they respectively had the formulae $C_{14}H_6O_4$ and $C_{14}H_4O_5$; and they succeeded in preparing alizarin by oxidising anthracene, then converting it into anthraquinone, $C_{14}H_8O_2$, from which dibromanthraquinone was prepared, and on heating this with potash alizarin was produced. This process was patented, but it did not prove to be of commercial value. Dr. Perkin, the well-known founder of the aniline-dye industry, who had devoted considerable attention to the investigation of anthracene, took up the subject at this point and he found, and Græbe and Liebermann simultaneously made the same discovery, that it was much better to employ sulphuric acid instead of bromine, i.e. to convert the anthraquinone into a sulpho-acid. Dr. Perkins' firm commenced the manufacture of alizarin in 1869, and up to the end of 1870 were practically the only manufacturers. They made 1 ton in 1869, 40 tons in 1870, 220 tons in 1871, 300 tons in 1872 and 435 tons in 1873. According to statistics quoted by Dr. Perkin from Græbe and Liebermann, the foreign production had advanced from 125–150 tons in 1871 to 900–1000 tons in 1873; and since then there has been a very considerable increase. Although England may thus be said to have been the birth-place of the manufacture of artificial alizarin, it is now chiefly manufactured abroad, notwithstanding that practically the whole of the anthracene and a large proportion of the other chemical materials required for its manufacture are produced in England. There is little doubt that this arises from the comparative neglect of chemistry, and especially the higher branches of chemistry, in this country.

In consequence of the large production of artificial alizarin and its low price, the cultivation of madder roots has become unremunerative; in fact, natural madder has now but a restricted use. The dyer has also derived considerable advantage in other ways from the introduction of alizarin. It was soon discovered that alizarin was not the only substance produced; two other bodies were separated from the crude product, both of the same composition as purpurin, but not identical with it in properties, and which have been termed *antra-purpurin* and *flavo-purpurin*. These and alizarin are now each manufactured in a state of purity, and by combining them in various proportions the dyer is able to produce a variety of shades; it is to this circumstance that artificial "alizarin" owes much of its popularity.

It should be mentioned that the manufacture of alizarin has given rise to another almost new industry—viz., that of sulphuric anhydride, which is now used to the extent of several hundred tons per annum in making anthraquinone-sulphonic acids. Formerly, it was entirely manufactured by distilling ferrie sulphate, and as this was carried on at Nordhausen in

Saxony, a solution of sulphuric anhydride in sulphuric acid was known as Nordhausen (fuming) sulphuric acid. The anhydride is now almost entirely made by combining sulphur dioxide with oxygen; no action takes place, even at high temperatures, between these gases alone, but readily in presence of so-called catalytic agents, such as finely divided metallic platinum, and it is by a process of this kind that it is now manufactured. Owing to the increase in the demand and the improvements in the manufacture, the anhydride is now worth about £40 per ton whereas ten years ago or so it was worth about £400 per ton.

A problem of great technical importance to which much attention has been devoted by chemists during recent years is that of the discovery of the nature of quinine; very considerable progress has been made in this direction, and there can no longer be any doubt that quinine and many other alkaloids are related in a more or less simple manner to certain bases which are contained in coal-tar. The probability, however, that a sufficiently simple process for the manufacture of quinine will be discovered is not great; but on the other hand substances more or less related to quinine have been artificially produced, which in their physiological action bear much resemblance to quinine. It is therefore not improbable that ere long chemists will achieve the triumph of discovering an efficient substitute for quinine, even if they do not succeed in devising a practical process for the manufacture of quinine itself.

It is impossible now in this notice to enter into a description of the numerous other chemical discoveries; all tell the same tale, however, and I cannot more fitly conclude than by recalling Hofmann's closing words to the section on coal-tar colours in his 1862 report: they are as pregnant with meaning as then, and it is perhaps even more necessary than it then was that they should be noted and acted upon. The history of the discovery of the methods of manufacturing aniline and indigo, to use Hofmann's words, "is a splendid demonstration of the power and utility of chemistry. But this history teaches us another and a nobler lesson still, and one which in closing this section, the reporter would once more recall: for it is apt to be forgotten in a great industrial country like England, where fortune ever tempts the chemist from the hard mountain path of pure scientific research to the smiling slopes of lucrative industrial applications. That lesson based on the discovery of benzol, and pointing to the illustrious name of its discoverer, Faraday, bids us if we would reach the noblest heights of fame, to seek pure truth; regardless of industrial advantage, yet sure that from our labours practical good will in due season flow for the benefit of all mankind."

It may be that the present Exhibition of Inventions will have the effect of leading the public to encourage and stimulate those who are toiling along "the hard mountain path of pure scientific research," and that they will see the importance and advantage of placing many of their more capable sons upon that path.

The period represented in this Exhibition has witnessed almost from their origin the rise and development of the two great industries which have supplied the world with mineral oils. The discovery of natural petroleum on the top of a coal-seam in Derbyshire, in scanty quantity, suggested the obtaining of a similar liquid by heating coal, or substances of a like nature, artificially. A few years later the introduction into America of artificial mineral oil directed attention to the natural petroleum, whose existence had long been known, and which was found on the surface in Oil Creek, Pennsylvania. In 1859 the first boring for oil was made. This novel mining had a marvellous development. It was found that the oil supply extended for hundreds of square miles; and some borings required no pumping, but spouted oil at the rate of a thousand or more barrels a day. The petroleum thus obtained, as well as the crude oil distilled from cannel coal or shale, needed treatment, to separate these complex liquids into more and less volatile portions fitted for different uses. The shale oil distillery has been pushed hard by having to compete with a natural supply of a purer material; and only the inventiveness which has been applied in perfecting the methods of distillation, and utilizing by-products, has enabled this industry to survive. The problems to be solved by the refiners of shale oil and petroleum were similar. Each liquid yields, on fractional distillation, a highly volatile and inflammable gasoline used for making "air-gas," light naphtha used as a solvent and for lamps without a wick, oil for ordinary lamps, and lubricating oil. Besides these, petroleum can be so treated as to yield about two per cent. of solid paraffin; while the crude shale oil yields ten or twelve per cent. of the same substance, which is obtained from it for candle-making in

large quantities. The methods of separating and purifying these products are the outcome of the suggestions and experiments of many inventors.

Only the less volatile burning-oils can safely be used in domestic lamps. The test of safety is the observation of the temperature to which the sample of oil can be raised before it volatilizes sufficiently to form a gas which will take fire upon its surface. Much ingenuity has been bestowed in devising an apparatus by which the quality of a sample of oil in this respect, or what is termed its "flashing point," may be determined under conditions which are perfectly definite and reproducible.

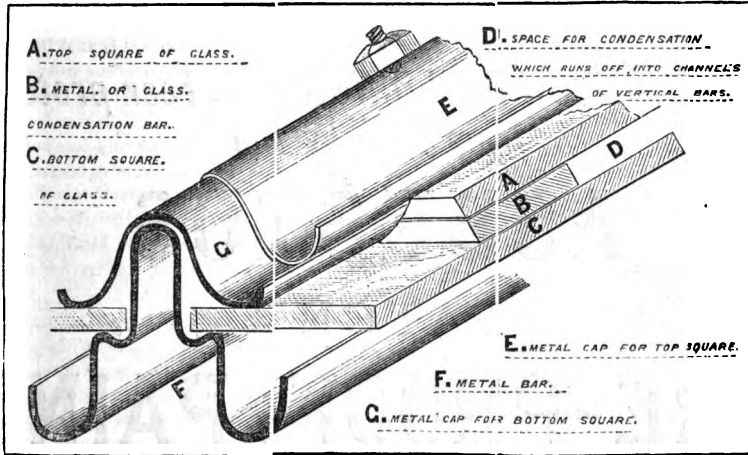
As sources of light, vegetable and animal oils have to a great extent been superseded by mineral oil; and in the older industries there is less scope for invention. Improvements have, however, been made in the application of hydraulic pressure to the extraction of oil, and the more complete separation of liquid from solid grease. That this separation should be as perfect as possible is desirable as affecting the quantity and quality of the oil extracted; but it is chiefly important as rendering the solid grease better fitted for candle-making. Not to be greasy to the touch, and not to gutter or bend in hot weather, stearic acid must be freed as far as possible from oleic acid, spermaceti from sperm oil, and the solid paraffins from their liquid homologues. Connected with candle-making are the improvements which have been made in the methods of saponification. It was found by degrees that the separation of glycerine from the acids with which it is associated in natural fats could be effected with less lime and less sulphuric acid when the fat was acted upon by either of these substances, which are used with water, at a higher temperature finally that, at a temperature just short of that at which glycerine is decomposed, water alone would effect the separation, and that in the same operation the glycerine and fatty acids could be distilled. The actual processes of candle-making have been gradually improved. Wicks are plaited more evenly by machinery, and the manual labour of fixing them in the moulds has been diminished by the adoption in some cases of a continuous process. A length of wick is wound on bobbins, and the removal of one candle draws into position the portion of wick which is required for the next. Wax at a temperature at which it is plastic may be squeezed out through a cylindrical spout in a continuous rod. Advantage has been found also in the mixture of heterogeneous materials; an addition of wax or paraffin to spermaceti or palmitin or stearin renders these substances less crystalline; an addition of stearin makes paraffin less flexible. Rushlights were succeeded by wax mortars, and these by night-lights, which are cylinders of fat in a casing of shaving or paper. A wax-covered wick, supported on a small piece of tin, is inserted, and cemented by pressing the night-light on a warm slab.

The introduction of mineral oil has simplified the construction of lamps. The clock-work of the Carcel, the spring, piston, and fine wire of the moderator, were ingenious devices for supplying oil abundantly to the wick within reach of the heat of the flame. Like spirits of wine, mineral oil is sufficiently limpid and volatile to rise an inch or two above the level of the liquid and feed the flame by its evaporation when drawn upwards by the capillary action of the wick alone. On the other hand, the lamp-maker had new problems to solve. The reservoir must not be heated nor the liquid exposed to the air, and the production of suitable air-currents required new arrangements of chimney and of metal guides. The "Duplex" lamp, producing two parallel flat flames, dates from 1865. Since then other combinations, aiming at an increase of the temperature and brightness of each flame by mutual radiation of heat, have been devised. The Argand form has reappeared, the seemingly round wick being bent into this shape by the wick-holder, which folds a flat wick as it rises, bringing the edges together so as to form a ring at the top. The problem of substituting in lighthouse lamps petroleum for the far more costly colza, has been successfully solved, the flow of oil being maintained at some distance below the surface of the wick, while the regulated air-supply passing on both sides of each annular wick-holder hinders the conduction of heat downwards. As compared with gas, an oil lamp has this disadvantage, that its flame cannot be super-heated and brightened by being fed with heated air.

In regard to domestic lamps, among the points to which the attention of an inventor needs to be directed, portability, arrangement of shades or reflectors, and, not least, appropriateness and beauty of design, must be included. Of candlesticks and candelabra, and of gas burners, excepting that they are not portable, the same is true; and inventiveness of a high order is required to combine the conditions of effective and economical lighting with graceful form, and to make the distribution of light in a room at once convenient and picturesque.

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year have had a coat of distemper over the Asbestos Paint.**

GROUP XIV.—APPARATUS, PROCESSES, AND APPLIANCES CONNECTED WITH APPLIED CHEMISTRY AND PHYSICS.

SOUTH CENTRAL GALLERY.

[For Chemical Apparatus used in Scientific Research, see Group XXVIII.]

1422. SMITH, JOHN MARTIN, 38 Borough Road, London, S.E.—Disinfecting Cleansing Powder.

1426. YOUNG'S PARAFFIN LIGHT & MINERAL OIL CO., Limited, 7 West George Street, Glasgow.—(1) Improvements in the manufacture of gasoline, naphtha, paraffin burning oils, paraffin wax and candles. (2) Lamps. (3) Lubricating Mineral Oils. (4) Sulphate of Ammonia. (5) Minor Products.—Basic Oils, Phenols or Creosotes, and Liquid or Low-melting Paraffins.

1427. BRITISH ALIZARINE CO., Limited (THE), 64 Cannon Street, London, E.C.; and Silvertown, E.—Manufacture of Alizarine.

1428. BURT, BOULTON, & HAYWOOD, 54 Rue Caumartin, Paris; and 64 Cannon Street, London, E.C.—Improvements in the antiseptic treatment of timber and manufacture of coal-tar products.

1429. COLEMAN, J. J., F.C.S., 45 West Nile Street, Glasgow.—Machine for condensing and liquefaction of gases. This exhibit is a model of apparatus which has been used on the large scale for condensing liquid hydrocarbons from the waste gas of paraffin oil works, and which can be employed for liquefaction of ethylene, marsh gas, oxygen, &c.

1430. WARREN, T. T. P. BRUCE, Tanworth Villa, Marlham Grove, Forest Gate, London, E.—Preparation of Petroleum, suitable for all the purposes to which bisulphide of carbon is applied in extracting oils, fats, and resins, obtaining anthracene and vulcanizing india-rubber. It is also suitable for the preparation of quick-drying paints, varnishes, and lacquers.

1431. STANFORD, E. C. C., Glenwood, Dalmeir, Dumbartonshire.—New method of treating seaweed.

1432. ORCHARD, JOHN, 100 High Street, Kensington, London, W.—Compressed and Liquefied Gases, Valves, and Bottles.

1433. WILSON, J. VEITCH, & CO., 290 Debbies Loan, Glasgow.—(1) Improvements in the manufacture of lubricating oils and oil for Batching jute. (2) Improved Canvas Belting for steam cylinders and every kind of machinery.

1434. WARREN'S OIL CO., Limited, Phoenix Oil Works, East Greenwich, London, S.E.—Improvements in lubricants.

1435. ENGELBERT & CO., 70 & 71 Bishopsgate Street, London, E.C.—Patent Lubricant.

1436. RIMMEL, EUGENE, 96 Strand, London, W.C.—(1) Myrogene, a new apparatus for extracting the perfume from fresh flowers. (2) New Sanitary Perfumery. (3) Toilet Articles.

1437. BARTH, GEORGE, & CO., 54 Poland Street, London, W.—(1) Apparatus for the administration of nitrous oxide gas in combination with ether. (2) Barth's Portable Apparatus for the inhalation of oxygen or other gas in combination with atmospheric air.

1438. CANNON, B., & CO., Lincoln.—(1) Concentrated Size. (2) Glue Powders.

1439. NORDENFELT, T., 53 Parliament Street, London, S.W.—New methods of extracting albumen, fish oil, glue, gum, &c., and of preparing guano from the residue.

1440. PATENT LIQUID FIRE-PROOF CYANITE PAINT CO., Gunter Grove Works, Chelsea, London, S.W.—Coloured Cyanite.

1441. EGLINGTON CHEMICAL CO. (THE), 27 St. Vincent Place, Glasgow.—(1) Chromate Leather, and goods made therefrom. (2) Samples of Bichromate of Potash. (3) Samples of Bichromate of Soda. (4) Samples of Chromate and Bichromate of Lime. (5) Samples of Chromate and Bichromate of Ammonia. (6) Samples of Chromate and Bichromate of Alumina.

1442. GRIFFITHS, BERDOE, & CO. (SANITARY PAINT CO.), Limited, 34 Leadenhall Street, London, E.C.; and 51 South John Street, Liverpool.—Knight's Patent White—non-poisonous substitute for white lead [Knight's improved process].

1443. GRIFFITHS, THOMAS, Inventors' Mart, 1 Queen Victoria Street, London, E.C.—Improved Non-poisonous Substitute for White Lead.

1444. CONTINENTAL DIAMOND ROCK BORING CO., Limited (THE), 4 The Sanctuary, Westminster, London, S.W.—Process for manufacturing white lead pigment.

1445. CONDY, H. B., Battersea, London, S.W.—(1) A New Permanganate Disinfectant [utilising oxygen hitherto wasted]. (2) A New Medicinal Salt, Hyposulphate of Soda; and a collection of other Hyposulphates. (3) A New and Rapid Process for the manufacture of white lead, harmless to the workmen.

1446. MACKEY, MACKEY, & CO., 1 & 2 Bouverie Street, Fleet Street, London, E.C.—(1) The Preparation of New Neutral Soluble Salts of Cerium, for medicinal purposes: viz. ammonio citrate of cerium, ammonio tartrate of cerium, potassio citrate of cerium, potassio tartrate of cerium, sodio citrate of cerium, sodio tartrate of cerium, lactates of cerium. (2) Animal, Vegetable, and Mineral Oils. (3) General Lubricating Compounds.

1447. ALEXANDER, J., & CO., 18 Paradise Street, Lambeth, London, S.E.—Hamamelis Toilet Soap, a form of soap made of the purest ingredients, with the introduction of Hamamelis Virginica or extract of witch hazel bark.

1448. FREEMAN, J. B., & CO., Grove Works, Battersea, London, S.W.—Patent Non-poisonous White Lead.

1449. DUNCAN, J. & J. A. R., & B. E. R. NEWLANDS, Clyde Wharf, Victoria Docks, London, E.—(1) Alum Process for removing potash from saccharine solutions. (2) Improvements in the manufacture of sulphate of alumina.

1452. BOLTON & PARTNERS, Limited, Malago Vale Works, Bristol; and 4 The Sanctuary, London, S.W.—(1) Strontia Paints, Colours, and Glazes. (2) Improvements in the manufacture of caustic soda.

1453. KELLY, R. R., 3 Pall Mall East, London, S.W.—Manufacture of Sulphate of Ammonia.

1454. PACKARD, EDWARD, & CO., Ipswich.—(1) Improvements in the manufacture of phosphoric acid and super-phosphates for export. (2) Phosphates of Soda, Potash, and other Compounds of Phosphoric Acid.

1455. AGRICULTURAL & HORTICULTURAL ASSOCIATION, Limited (THE), Creek Road, Deptford, London, S.E.; and 3 Agar Street, Strand, London, W.C.—Improved Artificial Manures.

1456. WEBB, EDWARD, & SONS, Royal Seed Establishment, Wordsley, Stourbridge; Manure Works, Widnes, Lancashire.—(1) Samples of Webb's Guaranteed Manures for all crops, prepared upon a practical and scientific basis. (2) Raw Materials from which the manures are manufactured.

1457. CLAY & LEVESLEY, Temple Mill Lane, Stratford, London, E.—Clay's Fertiliser, a special horticultural manure.

1458. BLAKE, BARCLAY, & CO., Victoria Works, Greenock.—Improved Retorts for the production of animal charcoal from bones, and for revivifying animal charcoal in sugar refineries.

1459. PATENT POROUS CARBON CO., Limited (THE), 23 & 24 Worm-

wood Street, London, E.C.; and Newton Abbot, South Devon.—Patent Carbon for deodorising sewage, filtration of water, refining of sugar, and decolourisation and purification of liquids; also for carbon closets, &c.

1460. CHEMICAL PAPERS CO Limited (THE), 3 Lombard Court, London, E.C.—(1) Improvements in manufacture of papers and felts for protective, antiseptic, and germicidal purposes. (2) Moist destroying Papers. (3) Anti-tarnish Paper and Building Papers.

1461. AUSTIN, JAMES BATTIE, Lime Kiln Dock, Hotwells Road, Bristol.—Patent Carbolic Powder, applied for various purposes.

1462. CHADWICK, ROBERT, SON, Clensmore Chemical Works, Kilmister.—(1) Improvement in extracting colouring matter and other substances from woods by steam process; also distillation ammonia. (2) Hygienic Crystals and Powders. (3) Disinfectant.

1463. LEVINSTEIN, L., & CO., Chemical Works, Blackley & Crumfall, near Manchester.—Aniline and Nitro Dyes and Raw Materials.

1466. CALVERT, F. C., & CO., Bradford, Manchester.—(1) Carbolic Soap. (2) Dye Stuffs from carbolic acid. (3) Disinfectants.

1467. SOCIETY OF CHEMICAL INDUSTRY, 85 Palace Chambers, Bristol Street, Westminster, S.W.—Collective exhibition of Members of the Society of Chemical Industry.

Dr. A. C. Burghardt, Manchester.—Patent Condenser for volatile liquids.

Mr. James Hargreaves, Farnworth, Widnes.—Model of Process for manufacture of sulphate of soda.

Mr. James Mactear, Glasgow.—Model of Calcining Furnace. (2) Chemical Saltcake Furnace. (3) Process for treating drainage from alkali waste.

Mr. W. Weldon, Rede Hall, Bideford, Devon.—(1) Process for manufacturing chlorine by manganite of calcium. (2) Process for manufacturing chlorine chloride of magnesium.

Messrs. Gaskell Deacon, Widnes.—Deacon's Chlorine Process with improvements. (2) Manufacture of anhydrous Carbonate of Soda, and Bicarbonate of Soda by Hurter and Carey processes.

Mr. L. Mond, London.—Recovery of Sulphur from alkali waste.

Messrs. Brunner, Mond & Co., Northwich.—(1) Manufacture of Ammonia Soda by Solvay's process and Mond's improvements. (2) Manufacture of Bicarbonate of Soda by Mond and Jarmay's process.

Bell Brothers, Middlesbrough.—Manufacture of Ammonia Soda by Schloesmg's process.

Jos. Gamble & Sons, Saint Helens.—Manufacture of Chlorate of Sodium.

James Muspratt & Sons, Widnes.—Manufacture of Chlorate of Potassium by Muspratt and Eschellmann's process.

A. Boake & Co., Stratford, E.—Manufacture of Liquid Sulphurous Acid and Sulphites.

Howard & Sons, Stratford.—(1) Manufacture of Pharmaceutical Preparations. (2) Patent Compressed Camphor.

May & Baker, Garden Wharf, Battersea.—Manufacture of Fine Chemicals.

Hopkin & Williams, 16 Cross Street, Hatton Garden.—Manufacture of Fine Chemicals.

Mackey, Mackey, & Co., 1 & 2 Bouverie Street, Fleet Street.—Manufacture of Soluble Salts of Cerium.

Miller & Co., Middlesbrough.—Manufacture of Nitro and Binitro Benzol.

Murkey White Lead Co., Warrington.—Manufacture of White Lead by Milner's process.

Roberts, Dale, & Co., Manchester.—Manufacture of Aurine.

Brooke, Simpson, & Spiller, Atlas Works, Hackney Wick.—Manufacture of Coal-tar Colours.

F. C. Calvert & Co., Manchester.—Manufacture of Carbolic Acid and Tar Products.

Chapman & Messel, Silvertown, E.—Manufacture of Anhydrous Sulphuric Acid.

Mr. G. E. Davis, Belmont, Thorncliffe, Sheffield.—Manufacture of Products from Coal.

T. B. Orr & Co., 46 Cannon Street, E.C.—Manufacture of Hygienic Paints.

Thomas Christy & Co., 155 Fenchurch Street, E.C.—Manufacture of Pharmaceutical Preparations.

Washington Chemical Co., Washington Durham.—Manufacture of Fine Chemicals.

Apothecaries' Hall, Blackfriars, E.C.—Manufacture of Pharmaceutical Preparations.

M. A. Eiloart, King's College, W.C.—Patent Gas Tap for chemical apparatus.

W. & TAYLOR, ALFRED, Lynton Mills, Pawson's Road, West Croydon.

(1) Excelsior Liquid Metal Polish. (2) Excelsior Furniture Polish. (3) Excelsior Burning and Lubricating Oil for bicycles and tricycles.

1460. LASCELLES-SCOTT, W., F.R.M.S., Forest Gate, Essex.—Diagrams showing improvements in apparatus for the preparation of pharmaceutical and other extracts.

BELLBY, GEORGE, Midcalder, N.B. (See Group XXVIII.)

BLAKESLEY, T. H., 25 Queen Anne's Gate, London, S.W. (See Group XXVIII.)

BOLTON & PARTNERS, Limited, Lavender Works, Suffolk; and 4 The Sanctuary, London, W. (See Group XVII.)

DE TIEBHABER, E. D., 2 Belle Vue Terrace, Crondance Road, Fulham, London, S.W. (See Group III.)

FIELD, J. & J. C., Lambeth Marsh, London, S.E. (See Group XI.)

HOLMES, J. R., 12 Waterloo Street, Glasgow. (See Group VII.)

MACPHERSON, DONALD, & CO., Knott Mill, Manchester, and 106 Cannon Street, London, E.C. (See Signal Arms of the British M&arski Tramway, Outside, South Promenade.)

PACKARD, E., & CO., Ipswich. (See Group XVII.)

PONTON, ARCHIBALD CAMPBELL, Viewfield, Parkstone, Dorsetshire. (See Group III.)

PRICE'S PATENT CANDLE CO., Limited, Belmont Works, Battersea, London, S.W. (See Group XI.)

RIDDELL, W. M., Westhall Road, Forest Hill, London, S.E. (See Group XXVI.)

SIMON, HENRY, 20 Mount Street, Manchester. (See Group II.)

THOMAS, S. G., & P. C. GILCHRIST, 9 Bridge Street, Westminster, London, S.W. (See Group II.)

WATSON, LAIDLAW, & CO., 88 Dundas Street, Kingston, Glasgow. (See Group IX.)

YOUNG, WILLIAM, & G. BELLBY, Priorsfield, Peebles, and Midcalder, N.B. (See Group XV.)

THE

'DEFRIES SAFETY LAMP,'

(SEPULCHRE'S PATENT.)

For Burning MINERAL OILS WITHOUT OFFENSIVE
SMELL OR DANGER.

This New Lamp, it is confidently anticipated, will inaugurate a **A NEW ERA IN DOMESTIC LIGHTING**, possessing as it does the following merits:—

Its Light is intensely white and **IS EQUAL TO 55 CANDLES**

Its cost for maintenance is only **ONE-THIRD OF A PENNY PER HOUR.**

It **NEVER EMITS ANY UNPLEASANT ODOUR** even if the Light be turned down.

It **HAS ONLY ONE WICK.**

It is **ABSOLUTELY SAFE**, under all conditions, **EVEN IF UPSET**, and

To obtain these Results any Petroleum Oil can be used.

MR. BOVERTON REDWOOD, F.G.S., F.I.C.,

In a Report made after a Series of Tests, *confirms the foregoing* (copy may be had on application), which proves the "**DEFRIES SAFETY LAMP**" to be the best ever offered.

SIR FREDERICK ABEL,

Chemist to the War Department, in a Lecture delivered at the Royal Institution, on March 13, on "Accidental Explosions caused by Non-Explosive Liquids," called special attention to the Lamp, and said:—

"... This was a lamp by Messrs. DEFRIES embodying all the features which exhaustive scientific enquiry have proved to be necessary for the perfectly safe use of mineral oils."

One Hanging Lamp is sufficient to Light a Room 20-ft. by 16-ft.

A SMALLER SIZE BURNER IS MADE FOR TABLE AND WALL LAMPS.

A Large Assortment may be seen ranging in value from 10s. to £100, at the Show Rooms of the Sole Makers,

J. DEFRIES & SONS,
147, HOUNDSDITCH, LONDON, E.C.

GAS AND OTHER ILLUMINANTS.

BY A. VERNON HARCOURT, M.A., LL.D., F.R.S., &c.

No great revolution in the manufacture of coal gas has taken place during the last twenty-five years, but in nearly every stage some important advances have been made. In long-established industries, whose details are the chief care of hundreds of busy minds enjoying a free interchange of ideas, inventions seem for the most part to grow rather than to be made. For, first, the accumulation and combination of little improvements is a gradual, almost a continuous process; and, secondly, the adoption of inventions, which may ultimately prove to be of great service, but which are novel and unfamiliar, is often very gradual or long delayed. Thus it happens that the advance of a manufacture within a given period may consist chiefly in the improvement and widening adoption of inventions of an earlier date, while some few inventions are accepted and do good service almost as soon as they appear, and many others, to be found and thought over in this Exhibition, still wait acceptance, and in the future will be the foundation of improved methods. For example, the substitution of clay for iron retorts, the combination of many retorts in a setting, the adoption of through retorts with a mouthpiece at each end, charging by scoop instead of by shovel, and by a mechanical arrangement instead of directly by hand, these and many other advances in the first stage of coal gas manufacture were thought of and began to be adopted before 1860, but their improvement or wider adoption since that date has been a progress of invention. Especially in matters of mechanical detail, such as the fixing of lids, the connections with the hydraulic main, the arrangement of condensers, the methods of washing gas thoroughly in a limited quantity of water, the construction of valves, of pumps, of exhausters, the actual progress from year to year is due to the making, the combination, and the adoption, of a multitude of small inventions. On the other hand, the heating of retorts by means of a combustible gas produced by the action of air and steam on coke, and the recovery, from the gaseous products of combustion, of heat hitherto wasted, are inventions of another class. The new processes seem likely, by lengthening the life of the retorts and economising labour and fuel, to cheapen materially the production of gas; and accordingly they are winning a speedy acceptance. As regards the purification of gas the chief advance has been in the improved use of old methods. The object in view is to remove ammonia, sulphur, and carbonic acid, and to do this by such means as will not add appreciably to the bad smells which cannot wholly be avoided in the manufacture of gas, and which are sometimes complained of by those whose houses adjoin gasworks. The more systematic and scientific application of oxide of iron and lime to the stream of gas, and the adoption of many precautions in disposing of the refuse material, have gone far during the last ten years towards the accomplishment of this object. The amount of sulphur in the atmosphere around a gas burner is, at least in London, less than half what it was a few years ago. There is still, however, a step in advance to be taken, eight or ten grains of sulphur in every 100 cubic feet of gas still to be removed, before gas can claim to be in this respect as perfect a domestic illuminant as candles or oil.

No great change but many improvements of detail have been made in the construction of gasholders and of their tanks; for the former, a simpler structure has been found sufficient, and the limit of size which is advantageous has probably been reached at a capacity of 3,000,000 cubic feet; in the construction of the latter, Portland cement concrete has in some instances replaced brick and puddle. So with the distribution of gas; mains up to four feet in diameter are now laid so perfectly that the loss by leakage has been greatly reduced, while by the aid of district governors the convenient pressure can be maintained at all levels and distances. In the protection of iron from corrosion a step forward has been made.

The use of the sulphur arrested by the oxide purifiers for making oil of vitriol, the manufacture of sulphate of ammonia, the development of tar distillery, and, above all, the production

of coal-tar colours, belong mainly to the period here illustrated. The great discovery of the methods for manufacturing the first aniline dyes from benzol was made in 1856 and the year or two following, but many additions to the series of dyes were made subsequently; and the artificial production of alizarine, the madder dye, from anthracene, a solid product of the distillation of coal-tar, dates from 1869. More recently a rival of cochineal has been obtained from naphthalene, another ingredient of coal-tar and of coal-gas, a substance which at low temperature is deposited from gas, as hoar frost from the air, and whose volatility has been turned to good account in the albo-carbon light.

In America, where coal is dearer and petroleum cheaper than in this country, various processes are in use for making illuminating gas by combining the combustible gases formed by the action of steam upon anthracite coal with those given off from petroleum or produced by its decomposition. In New York air and steam are blown for alternate periods of ten minutes through towers filled with glowing anthracite. The coal, intensely heated by the blast of steam, forms on contact with steam a mixture of hydrogen and carbonic oxide, with some carbonic acid which is subsequently removed; the hot gases pass over a shallow river of petroleum and then through heated retorts, where the hydrocarbons which would else be deposited on cooling, are decomposed into less condensable gases and a residuum of tar. If petroleum is run slowly through a red-hot retort a similar change takes place, the undiluted gas being of a much higher illuminative value than that yielded by cannel coal. This gas is well suited for being pumped under high pressure into a reservoir, from whence passing at a small rate to the burner, it gives a bright and steady flame. Another variety of illuminating gas, serviceable for large country-houses, is obtained by pumping air through a cistern charged with "gasoline," a volatile distillate of petroleum, into the main which supplies the house. In one form of apparatus, a drum within the cistern, turned by a cord and weight, serves at once to pump the air as it is wanted, and to bring it in contact with a large surface of gasoline.

The testings applicable to coal-gas are of three kinds—testings for pressure, for purity, and for illuminating power. Pressure-gauges for testing the difference between the tension of gas in a holder or pipe and of the air around, have various forms. They all indicate in tenths of an inch the length of the column of water which the gas can raise against the atmospheric pressure. Tests for ammonia and for sulphuretted hydrogen have long been in use, and hardly admit of improvement as technical tests. The Metropolis Gas Act, 1860, prescribed that there should not be more than twenty grains of sulphur in any form in one hundred cubic feet of gas. Since that time attention has been given to the methods by which the amount of sulphur in gas may be ascertained. In the same Act appeared the standard of light which is still in use, "a sperm candle of six to the pound burning one hundred and twenty grains an hour." This standard is liable to variations of ten per cent. or more. The invention and adoption of a better standard is urgently required both for scientific purposes, and to fix the quality, which is only another name for the price, of the gas with which we are supplied. A good standard must be constant, and must vary only in a known degree from known and measurable causes,—as, for example, the indications of the barometer vary in a known degree with the temperature of the mercury column,—it must be capable of easy and accurate reproduction, and it must be suitable for use in a photometer. The eye cannot estimate the relative brightness of two unequal lights, but can judge whether two adjoining portions of the same surface are equally illuminated. Improvements in photometry have aimed at placing the observer under the most favourable condition for obtaining and judging of equality of illumination, and for estimating quickly and exactly the distance of each light from the surface illuminated.

Many inventions have gone to the improvement of gas meters, the chief of which were made prior to 1860. When an instrument approaches perfection only small improvements are possible. The chief remaining defect of the "wet" meter was the variation in its registering due to a change in the volume of water within it; for the capacity of the measuring chamber, which are filled in succession as the meter-wheel goes round, is constant above, but below depends upon the level of the water which forms the floor of each chamber. Several methods have been devised for keeping this level constant; the problem has also been solved by making the meter-wheel itself return to the inlet a small volume of gas, less when the water level is high and the main delivery at each revolution is diminished, more when the water level falls and the main delivery is increased, so that the net delivery is within large limits independent

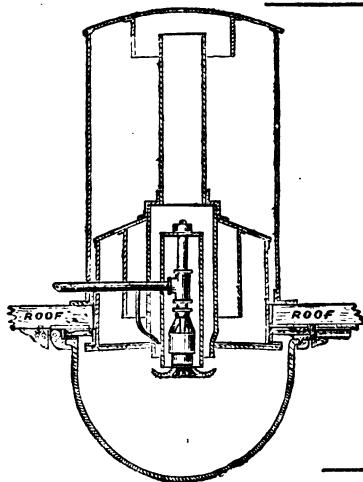
of the level of the water. As "wet" meters may be compared to bucket water-wheels filled with gas from beneath, whose work is to register the number of buckets full they discharge; so "dry" meters may be compared to air-engines driven by the pressure of the gas, whose work is to turn the dials which record how often each cylinder has been filled and emptied. The accuracy and permanence of dry meters depends upon excellence of workmanship in the construction of the moving parts, and upon the choice and preparation of the gas-tight and flexible material which forms the sides of the expanding chambers. Next to the meter should come in every gas-consumer's house a governor for keeping constant the pressure of gas within. When the pressure tends to increase and set burners flaring, this instrument partially closes the inlet by means of a valve attached to a bell or diaphragm which is raised by the pressure of the gas. The same principle is applied in many forms. Of these a glass or iron bell dipping into an annular trough filled with quicksilver is among the most recent and best. Small governors and rheometers have been invented for use with single burners. Rheometers, which should rather be called rheostats, deliver gas at a constant rate whatever may be the pressure at which the gas is supplied. The principle of them is that the stream of gas passes through a small hole at a constant difference of tension on the two sides, which is maintained, when the pressure at the inlet is increased, by the perforated diaphragm, whether bell, or cone, or plate, which acts upon the upward current of gas, rising a little and narrowing the outlet, until only this constant difference remains between the pressure above it and the pressure below.

In the improvement of gas burners, and in the adoption of improved burners, there has been much progress of late years. Seemingly small changes in the material and construction of burners of the familiar types, fishtail, batwing, Argand, have added twenty or even fifty per cent. to the light obtainable or commonly obtained from a given consumption of gas. To produce a steady and brilliant flame the gas must issue in a slow stream and be spread into a sheet, fan-shaped or cylindrical, of suitable thickness, so that the hydrocarbons may be decomposed by heat and partial combustion along the central plane, and the resulting smoke may continue to burn and glow as it spreads outwards for as long as is consistent with the development of sufficiently high temperature, and then may meet the outer air so suddenly and over so large a surface as to be completely consumed. The conditions to be fulfilled are better understood now than formerly; and much careful observation and ingenuity have been applied in bringing the best burners of the ordinary types to the degree of perfection which they have recently attained. Once again by the side of gradual improvement along the old lines we find some new departures. The same "regenerative" principle which promises to be serviceable in the retort-house aids gas also in its final stage. Within a few years the yield of light from a good burner, already double that from many of the burners in common use, has again been doubled by causing the flame to heat the air with which it is about to be fed. Where powerful lights are desired, a similar, though not equal, advantage has been obtained by placing two or more flames in close proximity. Each flame radiates heat to its neighbour; but the gain in incandescence is partly neutralised by the imperfect transparency of luminous flames. Multiple Argands, whose central cylinder of flame has a similar but larger flame round it, and so on, up to six or more layers of flame, furnish the best example of what is possible in this direction; but even their splendid light might perhaps be considerably increased by feeding them with heated air drawn from around the chimney above the flame. By mixing air with gas and expelling the mixture in a jet, by which more air is drawn in, a flame of higher temperature than an ordinary gas flame is obtained. Network of platinum or magnesia placed in such a flame glows with a more brilliant light than the gas would yield if burnt in the ordinary manner. But it may be doubted whether the gain can ever equal the cost of a supply of air much exceeding the gas in volume at a pressure of several inches of water.

GROUP 15. EAST ARCADE.

KIRKHAM, HERSEY & CLARK,

15, GREAT GEORGE ST., WESTMINSTER.

**Recuperative Gas Lamps
CLARK'S PATENT.**

The advantages claimed by the use of these Lamps are as follows:—

1st. An economy of about 75 per cent. in the Gas consumed as compared with ordinary burners.

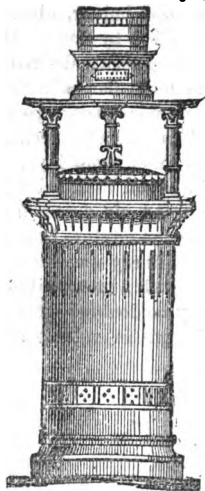
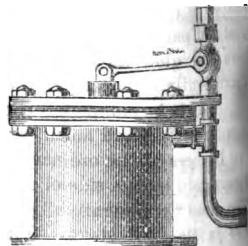
2nd. Greatly increased steadiness, and softened brilliancy of light, with entire absence of shadow.

3rd. Absolute immunity from smoke through perfect combustion.

4th. Absence of vitiation of air and assistance to ventilation.

**HIGH PRESSURE GAS GOVERNOR,
CLARK'S PATENT.**

In use on the Great Western and Great Northern Railways, giving great satisfaction.

**CHEAP LIGHTING BY GAS.**

For PLACES where there are no GAS WORKS.

PORTABLE APPARATUS

Supplied for any Number of Lights.

Suitable for LIGHTING and HEATING Houses, Churches, Railway Stations, &c.

AND ALSO FOR COOKING PURPOSES.

This mode of Lighting has been adopted for Ten years by Country Gentlemen in England.

Testimonials and Estimates for Fitting up these Machines will be sent on application.

The Silver Medal was awarded for this Apparatus at the International Gas Exhibition of 1883.

KIRKHAM, HERSEY & CLARK,
15, GREAT GEORGE STREET, WESTMINSTER.

GROUP XV.—GAS AND OTHER ILLUMINANTS.**EAST ARCADE.**

[For Electric Lighting, see Group XIII.; for Gas-stoves, see Group XVI.; for Photometrical Apparatus, see also Group XXVIII.]

1473. **KIRKHAM, HERSEY & LARK**, 15 Great George Street, Westminster, London, S.W.—Gas-making apparatus.

1474. **DOULTON & CO.**, Lambeth Pottery, London, S.E. — Instantaneous Water Boiler.

1475. **WALLER, GEORGE, & CO.**, Holland Street, Southwark, London, E.—(1) Patent Three-Blade Gas Exhauster. (2) Patent Compensating Governor. (3) Patent Retort Lid and Mouthpiece. (4) Patent Absorbent Retort Valve. (5) Patent Three-Blade Exhauster and Combined Engine. (6) Waller's Retort Gas Valve. (7) Box and Waller's Retort Washer-Scrubber.

1476. **SOMERVILLE, JOHN**, 70 Abchurch Lane, Southwark, London, S.E. — (1) Working Model of Machine for drawing and heating gas retorts. (2) Self-sealing Mouthpiece and Lid for gas retorts. (3) Machine for making coke for domestic use. (4) Hydraulic Dip-reducer. (5) Model of a regenerative process for heating gas retorts, suitable for and floor retort houses.

1477. **HEARSON, CHARLES, & CO.**, Limited, 235 Regent Street, London, W.—Sun Gas-making Machine for 200 lights. This apparatus makes gas from gasoline.

1478. **WRIGHT, ALEXANDER, & CO.**, 55, 55a, & 56 Millbank Street, Westminster, London, S.W. — (1) Gas Meters. (2) Pressure Regulators. (3) Pressure Gauges. (4) Hartley's Gas Calorimeters. (5) Hanson's Solid Fuel Calorimeters. (6) New Precision-Standard Gas Meter. (7) Public Gas Meter. (8) Methven's Photometric Units. (9) Standards of Light. (10) Analytical and Test Instruments for gas. (11) Hartley's Universal Photometer and Appliances. (12) Improved Standard Photometric Apparatus.

1479. **SUGG, WILLIAM, & CO.**, Lion Works, Vincent Works, Westminster, London, S.W. — (1) Patent Illuminating Gas Meter. (2) Improved Cubic Foot Measuring and Meter. (3) Patent Street Lamp Burners. (4) London Argand Burners. (5) Argand and other Flat Flame Burners. (6) Filling Valves. (7) Railway Carriage Lamp and Gas Supply Joint. (8) High Power Street Burners and Ventilating Argand Burners. (9) Harrison's Patent Aerothermometer. (10) Joshi's Patent Indicator. (11) Patent Improved Burners, Mercurial Gas Governor and Valve Joint. (12) Vincent and Cromarty

Ventilating Light. (13) Coffee Roaster. (14) Improved Canadian Pattern Letheby Photometer. (15) Jet Photometer, Ten Candle Test.

1480. **BROMHEAD & CO.**, 28 Paternoster Row, London, E.C.—(1) Automatic Dry Gas Regulator. (2) Instrument for producing improved light in public conveyances.

1481. **CHATWOOD, SAMUEL**, Lancashire Safe and Lock Works, Bolton; and 76 Newgate Street, London, E.C.—(1) Improvements in fire and burglar proof safes, bankers' strong rooms, and locks for same. (2) Burners for producing light by heating refractory metals as platinum to incandescence.

1482. **UNIVERSAL ELECTRIC LIGHT & ENGINEERING CO.**, 13-14 King Street, Cheapside, London, E.C.—The Morgan & Shippey process for withdrawing the natural gases from coalmines, and the utilisation and application of same for generating steam as an economical system for the lighting of coalmines by electricity; the working of mining machinery by electricity; the driving electrical machines for motive-power purposes; the lighting of colliery district towns and villages by natural mine gas, &c.

1483. **WEST RIDING CANDLE COMPANY**, Rotherham, Yorkshire.—Improvements in the construction of mould candles, so constructed as to fit tightly in any candelabra or ordinary candlestick, forming an excellent finish to the same, with a great saving to the consumer; also Self-adjusting Globe to prevent the guttering of candles and soften the light of same.

1484. **BEAUMONT, G., & CO.**, 13 Red Lion Square, London, E.C.—(1) Improved Candle Shade Holders. (2) Supports. (3) Candlesticks. (4) Lamps, Lamp Shades, &c.

1485. **GLOVER, GEORGE, & CO.**, Royal Avenue, Chelsea, London, S.W.—(1) Patent Dry Gas Meters, with improvements to secure accuracy and durability, including patent valve guides. (2) Gas-holders for testing gas meters.

1486. **YOUNG, W., & G. BEILBY**, Priorsford, Peebles, and Midcalder, N.B.—(1) Improvements in the process of refining and separating the products of crude paraffin oil. (2) Process and apparatus for the recovery of the nitrogen of carbonaceous substances as ammonia in connection with the use of these substances in the paraffin oil, the illuminating gas, and the fuel gas industry.

1487. **FLEISCHER, MÜLLER, & CO.**, Frankfurt-on-the-Maine, Germany.—(1) Gas Pressure Regulators for gas engines. (2) Gas Pressure Regulators and Gas Saving Apparatuses for gas lighting.

1488. **CLAPHAM BROTHERS**, Keighley, Yorkshire.—Eclipse Washer-Scrubber for extracting ammonia and other

impurities from coal gas [Laycock and Clapham's Patent].

1489. GAS APPLIANCES CO., Limited, 29 New Bridge Street, London, E.C.—Governor Condenser Washer Scrubber.

1491. SALE, F., 129 Oxford Street, London, W.—Little Princess Lamp.

1492. FAIRFAX, J. S., 3 St. Paul's Road, Camden Square, London, N.W.—(1) Improved Burners and Wicks for oil lamps. (2) Lamps combined with stereoscope, reading desk, and mirror. (3) Ordinary Illuminating and Heating Lamps.

1493. KYNOCH, G., & COMPANY, Limited, 199 Piccadilly, London, W.; and Lion Works, Witton, Birmingham.—Martin's Patent Lamp.

1494. COWAN, W. & B., Smith Square Works, Westminster, London, S.W.; Dutton Street Works, Manchester; and Buccleuch Street Works, Edinburgh.—(1) Warner & Cowan's Patent Self-regulating Drum Wet Gas Meter. (2) Apparatus for testing gas meter indices. (3) Gas Works Governor. (4) Automatic Pressure Changer for governor. (5) Photographic Gas Pressure Register. (6) Retort House Governor. (7) Water-loading Tap Closer for governors.

1495. ALBO-CARBON LIGHT COMPANY (THE), 132 Horseferry Road, Westminster, London, S.W.—Albo-Carbon Light Apparatus for increasing the illuminating power of ordinary coal gas at a greatly reduced cost, with much less heat, and a purer atmosphere.

1496. FREESTON, JAMES, & GEO. KYLE, Geddington, Kettering.—Patent Self-acting Regulating Machine for extinguishing and relighting gas lamps for street purposes.

1497. WENHAM PATENT GAS LAMP COMPANY, Limited (THE), 12 Rathbone Place, London, W.—Patent Regenerative Gas Lamps. A new system of burning gas, whereby its illuminating power is increased.

1498. LUMLEY, THEODORE, Devonshire Club, St. James's Street, London, S.W.—Combined Street Lamp, Post Office Letter-box and Fire Alarm.

1499. LEWIS INCANDESCENT GAS LIGHT COMPANY, Limited (THE), 57 Moorgate Street, London, E.C.—Incandescent Gas Burner.

1500. PATENT ARGAND GAS AND OIL BURNERS CO., Limited (THE), Leadenhall House, 101 Leadenhall Street, London, E.C.—The Sirius Mineral Oil Burner.

1501. TICE, WM., Thornilee, Sutton, Surrey.—(1) Apparatus for warming railway carriages, &c. (2) Improved Dry Gas Regulators and Governors.

1502. GREY, SAMUEL, 16 Whitehead's Grove, Chelsea, London, S.W.—(1) Readable Water Meter Index. (2) Readable Engine Counters. (3) Readable Electrical Meter Indices. (4) Indices for meters of different sizes.

1503. BROWNE & CO., 186 Piccadilly, London, W.—(1) The Mitrailleuse Lamp. (2) Duplex Lamp, showing improvement facilitate trimming and lighting. (3) New Candle Lamp for dining table and reading purposes.

1504. HARDING, T. R., & SON, Town Works, Leeds.—(1) Meter Counters. (2) Engine and Machine Counters. (3) Special Indicators and British Standard Wire Gauge. (4) Harding's Counter as applied for registering the flow of liquids.

1505. KINNEAR'S PATENTS, Limited, 91 Finsbury Pavement, London, E.C.—Self-lighting Gas Burner and Tap Governor; lights instantly by turning the handle and effects a saving of over 25 per cent. of gas and secures immunity from explosions and

1506. BUCK & WOOTTON, Westminster Bridge Road, London, S.W.—Candle Fixers, for instantly centering and fixing candles in candlesticks.

1507. DANIELL, WILLIAM, 100 Road, Linslade, Leighton Buzzard, Bedfordshire.—Improvements in oil lamps and chandeliers.

1508. FLATAU & TURNER, 9 Market Lane, London, E.C.—Lamps burning mineral oils without wick.

1509. GYE, LIONEL, 44 Dover Street, London, S.W.—Lamps and Candles, means of regulating height of shades, glass, &c.

1510. GARRATT & FOWLER, 51 Leipsic Road, Camberwell, London, S.E.—(1) Improvement in the construction of unions to prevent the strain on the pipes at each joint in the connecting and disconnecting. (2) Improvement in blow lamps for the use of plumbers, gasfitters, and painters.

1511. GRAY, J. W., & SON, Leadenhall Street, London, E.C.—Wickless Non-guttering Candle.

1512. JONES & WILLIS, 43 G Russell Street, London, W.C.; and Edmund Street, Birmingham.—The perus Lamp, to burn mineral oil.

1513. PARKES, ALFRED, Works, Wolverhampton.—Telescope way Reading Lamp.

1514. PERKINS, ALFRED, 123 Uxbridge Road, London, W.—(1) Improved Apparatus in or by which coal gas can be burnt alone, or enriched by admixture with Hydrocarbon Vapour, also as a smoke consumer. (2)

An improvement connected with register stoves and other firegrates, for the better prevention of fire in dwelling houses and other buildings.

1515. ESTCOURT, CHARLES, 29 Princess Street, Manchester. — Improvements in the purification of coal gas. The process consists in passing crude coal gas [which always contains sulphuretted hydrogen in large quantities] through a chemical solution in closed vessels. The sulphuretted hydrogen is decomposed, and the sulphur is precipitated from it in a form which is readily rendered soluble. Thus, gas purification may be conducted in closed vessels and by an automatic process.

1516. DUCHAMPS, E. G., C.E., 14 Proxton Park, West Dulwich, London, E.E. — Apparatus for carburetting air for illuminating and other purposes.

1517. BOWER, GEORGE, St. Neots, Huntingdonshire. — The Bower Duplex Regenerative Gas Lamp, by which the light obtainable from gas is more than doubled without any aid from reflection, or from extra carburation.

1518. JOLY, JOHN, 43 Pembroke Road, Dublin. — Sensitive Photometer.

1519. BROWN, B. & J., & CO., 39 Charlotte Street, Blackfriars Road, London, S.E. — (1) Improved Patent Apparatus for lighting street lamps. (2) Improved Street Lamp for gas or oil.

1520. CANIK, THOMAS, 2 Westburne Terrace, Malvern Link, Worcestershire. — (1) Improved Apparatus for lighting and extinguishing gas by variation of pressure and electricity. (2) An Automatic Pressure Changing Gas Governor.

1521. PARKINSON, W., & CO., Cot- tage Lane Works, City Road, London, E.C. — (1) Beechy's Patent Anti-Fluctuator for preventing oscillation of lights caused by the working of gas engines. (2) Patent Three-partition Measuring Drum for wet gas meters and water meters.

1522. DEFRIES & SONS, J., 147 Roundelitch, London, E. — Safety Lamp.

1523. CARTER & LEES, Egerton Works, Union Street, Oldham. — Improvements in gas regulators.

1524. FOXALL, LLEWELLIN, JONES, & CO., Charlotte Street, Newport, Mon. — Patent Wet and Dry Gas Meters with Patent Clock Dials or Ordinary Index.

1525. TYNDALL, F. T., Albert Gallery, Edinburgh. — Railway Carriage Reading Lamp.

AYRTON & PERRY, 73 Great Eastern Street, London, E.C. (See Group XIII.)

AVERY, W. & T., Digbeth, Birmingham; and **14, 15 & 16** Cow Cross Street, London, E.C. (See Group XI., Queen's Gate Annex.)

BALFOUR & CO., Lane End Works, Longton, and Tamworth. (See Group III.)

BEYNON & COX, Torbay Iron Works, Torquay, Devon. (See Group IV.)

COXETER & NEHMER, 23 & 24 Grafton Street East, Tottenham Court Road, London, W. (See Group XIII.)

EASTON & ANDERSON, 3 Whitehall Place, London, S.W. (See Group III.)

FIELD, J. & J. C., Lambeth Marsh, London, S.E. (See Group XI.)

FOULIS, JOHN, 28 Market Place, Musselburgh, Midlothian, N.E. (See Group XI.)

GLOVER, G., & CO., Ranelagh Works, Royal Avenue, Chelsea, London, S.W. (See Group XXVIII.)

HOW, JAMES, & CO., 73 Farringdon Street, London, E.C. (See Group XXVIII.)

KULLBERG, VICTOR, 105 Liverpool Road, Islington, London, N. (See Group XXVII.)

PLUMPTON, GEORGE, Albion Tool and File Works, Warrington, Lancashire. (See Group XXIV.)

PRICE'S PATENT CANDLE CO., Limited, Belmont Works, Battersea, London, S.W. (See Group XI.)

READ, JEFFERSON, 17 Augusta Street, Birmingham. (See Group XXIV.)

SALOMONS, SIR DAVID, Bart., Broomhill, Tunbridge Wells. (See Group XXVIII.)

SALSBURY, JOHN E., 125 & 126 Long Acre, London. (See Group VI.)

TRIER BROTHERS, 19 Great George Street, Westminster, London, S.W. (See Group IV.)

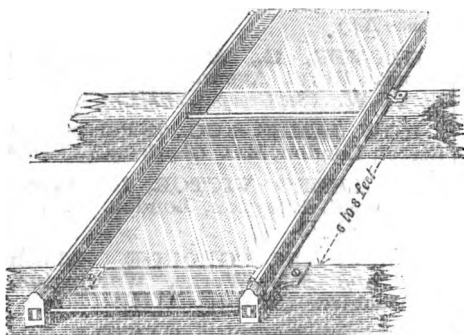
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MACKENZIE'S PATENTS.

NO PUTTY. NO ZINC. NO INDIA-RUBBER.

THE ONLY SOLID ROLLED MALLEABLE IRON PATENT GLAZING BAR.



It forms part of the Structure. Combines the Maximum of Strength with the Minimum of Bulk. Can be erected in any weather, and repaired by comparatively unskilled labour. The glass rests upon a cushion of soft metal, thus rendering it secure against shocks of vibration. The moisture condensed on inner surface of glass is carried off by gutters in the glazing bar. The under surface of the bar being sheathed in lead, the sulphurous fumes cannot act upon the iron. This is invaluable in Railway Stations. Full particulars on application. Drawings and Specifications of Roofs prepared.

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GENERAL MANAGER: WM. ATCHISON, ASSOC. INST. C.E.

Agent for Scotland:—A. D. BROWN, 81, MURRAYGATE, DUNDEE.

FUEL, FURNACES, &c.

By GEORGE J. SNELUS, F.C.S.A., R.S.M., WORKINGTON.

The most important varieties of fuel are:—1. Wood. 2. Peat. 3. Lignite or Brown Coal. 4. Coal from the true Carboniferous period—(a) Cannel Coal, (b) Bituminous Coal, (c) Steam Coal, (d) Anthracite. 5. Mineral Oils. 6. Natural Gas.

The origin of all these varieties of fuel is undoubtedly vegetable matter in some of its various forms. The all-powerful rays of the sun enable living plants to dissociate the carbonic acid of our atmosphere, and to store up in their substance various combinations of carbon with hydrogen, nitrogen and water. Certain changes take place in the composition of the plant tissues by which, as the plant ages, the composition of its substance becomes more and more highly carbonaceous. Resinous products are also deposited in the plant cells during growth, varying greatly with the kind of plant. The dry hard substance of the tree or plant constitutes the various kinds of wood. As a rule the hardest woods are the results of slow growth. There is little difference in the comparative composition of the woods of various kinds. The following is approximately the composition of beech, oak, and birch, exclusive of ash:—carbon, 50 per cent.; hydrogen, 6 per cent.; oxygen, 43 per cent.; nitrogen, 1 per cent.

The accumulation of vegetable matter in swampy places or in moist foggy regions during long ages gives rise to peat, which varies greatly according to the plants from which it was formed, and to the depth of the accumulation. Lignite or brown coal is vegetable matter which has undergone a further change due to time and pressure, and is found mainly in tertiary strata, although some probably belongs to secondary strata.

The accumulation of vegetable matter in the Carboniferous series gives rise to the series of stone coals. They vary according to the mode of formation, and to the amount of pressure and heat to which they have been subjected. Cannel and bituminous coals seem to have been subject to comparatively small pressure and heat, the effect of the intense action of the agents upon the carboniferous deposits giving rise to steam coal and anthracite, and probably to mineral oils and natural gas.

1. *Wood*.—This is the only fuel universally employed in all early stages of civilisation. For domestic purposes it is a serviceable fuel so long as it can be obtained cheaply; but the depopulation of forests gradually increases its cost to towns and cities, and its place becomes supplied by the less bulky and cheaper forms of coal.

For metallurgical purposes it was very early found desirable to intensify the heating property of wood by carbonising it or converting it into charcoal.

This is effected by piling the pieces of wood into a heap, covering them up with soil so as to exclude the air as much as possible, and then allowing the pile to burn slowly. The more inflammable constituents of the wood are gradually consumed by the small portion of air which permeates the heap, other constituents are volatilised, but the carbonaceous residue remains behind and constitutes charcoal. The production of charcoal is quite an art, and is practised by all nations. In the middle ages it was a very important manufacture in this country, but the great development of iron works led to such an enormous consumption, that the forests of the country were rapidly denuded, and special legislation had to be adopted to stop it. Where wood is plentiful charcoal furnaces are still employed in the production of iron, the quality of the product being superior to that made with coal or coke. Charcoal furnaces have all but died out in this country, but in the United States, in Sweden, and Austria, the manufacture of charcoal iron is still a large industry, and consumes annually an enormous quantity of wood. No great improvements in the use of wood as a fuel or in the production of charcoal have been recorded during the last twenty-five years.

2. *Peat*.—Vast areas of country are covered with this material, but so far, although numberless plans have been tried, no really cheap and effective mode of preparing it as a fuel has been discovered. To cut it into blocks, stack, and air-dry it, still appears to be the only mode of preparation which will pay.

3. *Lignite or Brown Coal* is much used for metallurgical purposes in Germany and Austria; but is almost unknown in this country.

4. *Coal*, either in its raw state or prepared as coke, is the principal fuel employed in this country and in many others.

The enormous deposits which England possesses have been the main source of her great power, but such rapid inroads are being made in these stores of force that they cannot possibly last very long. How long is a moot point which has been variously estimated. The committee appointed in 1866 to investigate the question of the exhaustion of our coal-fields, of which the Duke of Argyll was chairman, reported that our available supply of coal in Great Britain amounted to 146,480,000,000 tons.

The following table (I.), showing the quantity raised each year for the last eleven years, will serve to show the rate at which we are drawing upon our national bank. While Table II. will show the production of coal in the chief coal-producing countries of the world from 1866 to 1883 (1 = 1000 tons). These tables are furnished by Mr. Jeans, Secretary of the British Iron Trade Association.

TABLE I., SHOWING THE PRODUCTION OF COAL IN THE UNITED KINGDOM 1873 TO 1884
(BOTH INCLUSIVE).

1873.	1875.	1878.	1880.	1882.	1883.	1884.
Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
127,016,747	131,867,105	132,607,866	146,818,622	156,499,977	163,737,327	160,000,000

TABLE II. (1 = 1000 TONS).

Year.	United Kingdom.	United States.	Germany.	France.	Belgium.	Russia.	Austria.*	Total†
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
1866	111,442	21,856	21,629	12,234	12,774	390	2,920	183,246
1867	104,309	25,505	23,808	12,533	12,755	437	3,100	189,347
1868	102,948	28,258	25,704	13,330	12,298	500	3,600	186,638
1869	107,506	28,268	26,774	13,509	12,943	610	3,850	199,460
1870	109,035	35,468	26,397	13,330	13,697	760	4,295	202,962
1871	117,264	41,384	29,373	13,258	13,733	829	4,469	220,810
1872	123,492	45,416	33,306	15,802	15,658	1,097	4,788	239,559
1873	127,011	51,004	36,392	17,485	15,778	1,170	5,171	254,011
1874	124,937	46,916	35,918	17,059	14,669	1,369	5,096	245,966
1875	131,861	46,686	37,436	16,949	15,011	1,709	5,185	254,837
1876	133,470	47,590	38,454	17,104	14,329	2,050	5,564	258,471
1877	134,610	49,600	37,576	16,889	13,938	2,360	5,800	260,773
1878	132,607	52,700	39,000	17,000	14,500	2,500	6,100	264,407
1879	134,008	61,200	42,025	17,110	15,447	2,846	6,400	279,036
1880	146,818	70,100	46,973	19,361	16,865	3,188	6,700	310,000
1881	154,184	76,200	48,688	19,765	16,873	3,437	6,343	315,496
1882	156,499	77,000	51,000	20,803	17,485	3,500	7,184	...
1883	168,737	72,000‡	55,000	21,500	18,177	3,780‡	6,559	...

* Does not include brown coal, of which about nine million tons are now raised annually.

† The totals do not, of course, include the considerable quantities of coal raised in Spain, India, and other countries.

‡ Estimated.

In working coal very large quantities of small are produced, and this was often thrown to the waste heap. It is now very largely washed by special machinery and either made into coke or into patent fuel. One of the most perfect washing machines for small coal has recently been erected at Dowlais, South Wales, by Messrs. Evence, Coppée, & Co., Limited, Cardiff, and is capable of dealing with a thousand tons per day of ten hours.

The use of feldspar (a mineral of less specific gravity than the pyrites and shale found with coal, but greater than the coal itself), as a medium for separating the dirt from clean coal, is a very happy expedient, and very effective. Various methods have been adopted for washing small coal into blocks, and the manufacture of so-called "artificial" fuel is quite a large industry in South Wales.

The following is a description of the process by Thomas Evans, M.Inst.C.E., Cardiff.

Under the denomination "patent fuel" a great many ideas have been worked out to produce a good commercial fuel for house and steam purposes by mixing various substances with small coal in proportions sufficient to stick the particles of coal together to enable the mixture to be pressed into a block.

Only a few plans have been tried upon anything like a large scale, and at the present time probably coal-tar pitch is the only substance used for mixing with the coal.

Farina, made from potatoes, has had a good trial, but abandoned principally because the blocks were not waterproof, and the extra cost of covering each block with a watertight material would be too costly. A description of this process can be seen in the Transactions of the South Wales Institute of Engineers.

Coal-tar was used in a Swansea works under the name of Warliok's process. The blocks were baked after being pressed, whereby a quantity of tar was again extracted. These blocks have been shut up for some years, probably through the competition of newer works producing fuel by the coal-tar pitch plans.

Clay has been tried and makes fairly good fuel, but it is a substance that does not add to the burning qualities and increases the ash. The blocks will not stand exposure to the weather for any length of time.

Pitch made from coal-tar has been used for a great many years with much success by processes which may be generally divided into two, namely, the dry-heat process and the steam process. These two are at the present time probably the only ones being used.

The Dry Process.—Small coal is carried by an elevator into a large bunker, from which it is again lifted by another elevator to a shoot into which it is tipped with the contents of a smaller elevator containing pitch.

The buckets of these elevators are proportioned so that the right quantity of pitch shall be added with the coal. From the elevators the mixture goes into a Carr's disintegrator, or other machine where it is well incorporated in the proportions of from 8 to 12 per cent. of pitch, depending on the quality of pitch, fineness and dryness of coal, &c.

After passing through the mill it passes to the heaters, where it is thoroughly coked, and is taken to the presses, of which there are several very good kinds turning out from 10 to 200 tons of blocks per day of twelve hours, varying from 10 to 30 lbs. each. The blocks are taken from the presses upon wire ropes stretched side by side.

The Steam Process.—This process differs from the dry heat one by using a large vertical cylinder, with arms revolving inside similar to an ordinary pug-mill. It is constantly filled with the mixture of pitch and coal. High-pressure steam is injected near the bottom, and allowed to percolate up through the mass, while the arms thoroughly expose every portion to the action. These processes have a wide reputation, but the writer considers "the dry process" to be the best and cheapest when works for manufacturing patent fuel by its use are properly designed.

Every improvement by which a ton of coal can be made to do more work, or by which coal can be saved, is a national gain, and when we consider the enormous quantities consumed by the mercantile marine the economy of fuel effected by the modern triple expansion engines is of great importance.

There are several boats with these engines running between London and the colonies of Australia and New Zealand. For example, there is a vessel 362 ft. 5 ins. \times 44 ft. 4 ins. \times 23 ft. draught, gross tonnage 3616, which steams $12\frac{1}{2}$ knots per hour continuously on a consumption of 36

tons per day (i.e. 1.6 lbs. per indicated horse power). A somewhat similar vessel 389 ft. 0 in. by 42 ft. 1 in. \times 28 ft. 8 ins., gross tonnage 3594, with compound engines, engaged on the same voyage, burns 41 tons or quite 2 lbs. per indicated horse power.

The greatest demand upon our stores of fuel is made by the iron and steel manufacturing and we hail with satisfaction every change in this industry by which a saving can be produced.

Great economy has been effected in the consumption of fuel in blast furnaces by improvements in their construction, by the introduction of fire-brick stoves and the complete utilisation of the waste gases.

A ton of iron can now be made with very little more, and in some cases it is said with less than a ton of coke, whereas twenty-five years ago the consumption would average 26 or 27 cwt. Besides this, a large quantity of coal was formerly used for firing boilers and stoves, whereas now the whole of this duty is performed by the waste gases from the furnace, and it is considered that further duty still may be obtained by the efficient use of the waste gas.

In coking coal considerable progress has been made. The greatest improvement has been the introduction of the Coppee oven. This is a long rectangular oven about two feet wide and twenty feet from front to back. The products of combustion are taken off and burnt in furnaces on the side walls and under the bottom of the oven, thus raising its temperature materially. The coke is pushed out by mechanical means and cooled outside, thus keeping the oven hot.

Several systems are now before the public for recovering the waste products during the coking process. The Simon-Carvès process appears to be the most successful up to the present.

The modern processes of steel making, which have been the growth almost entirely of the last twenty-five years, have enormously reduced the demand upon our national store of fuel. A ton of malleable metal produced, for whereas in 1860 it took about two tons of coal to make a ton of malleable iron, a ton of steel can now be produced for an expenditure of not more than 30 cwt. for all purposes.

During the past twenty-five years great progress has been made in the use of gas fuel for manufacturing processes, especially as applied to the glass manufacture and to metallurgical operations. This has been almost entirely due to the development of the regenerative principle of the late Sir William Siemens. In this furnace, which dates, in its present form, from 1855, the fuel is transformed, in a separate gas producer, into a mixture containing about 30.5 per cent. (CO) carbonic oxide, 2.5 per cent. (H) hydrogen, 4.0 per cent. (CO₂) carbonic acid, and 63.0 per cent. (N) nitrogen, 3.5 marsh gas.

The gas generator of Siemens is a rectangular chamber about six feet wide, six feet deep, three feet from front to back, the front part sloping outwards from the grate. The sides are of firebrick, and an aperture at the top of the back wall allows the gas to pass into the upright chimney and thence to the gas main. The top of the producer is covered with firebrick, and charging holes are placed in the arch for the admission of fuel. After the fire has been fully lighted the raw coal is charged, until there is a depth of three to five feet on the grate. The (CO₂) carbonic acid first formed in passing up through the column of incandescent fuel is transformed into (CO) carbonic oxide. Several modifications of this producer have been attempted, that of Wilson being the most important.

The gas from the producers, of which four are usually placed side by side, working into a common chimney, is carried by the gas main to the furnace. This may be of any convenient shape, and connected with it are four chambers filled with a loose mass of brickwork, which are termed regenerators. The waste heat from the furnace passes through two of these chambers, leaving most of the sensible heat stored up in the loose brickwork. The current is then reversed by suitable valves, and the gas passes up through one regenerator and then through the other, and meeting in the furnace itself, intense combustion ensues, producing the highest temperature yet attained on the large scale. Until recently it has been considered necessary to bring the flame into contact with the substance to be heated by contracting the furnace chamber and dipping the roof, but Mr. F. Siemens has recently propounded the doctrine that in order to attain the best results the chamber should be enlarged so as to give the flame plenty of room, and that the heat is to be transmitted to the material in the furnace by radiation alone. A great saving in fuel is said to be the result of this plan. The application of Siemens gas furnaces to metallurgical and other operations will be treated more fully in the articles of Group II. and other Groups.

Since the Siemens furnace has been in use, several attempts have been made to regenerate the waste heat without the complication of valves and reversing currents. In many of these plans the waste heat is made to pass through or around fire-clay tubes, the incoming air passing around or through these tubes in the opposite direction. One of the most successful furnaces on this type is the Gorman. In this the coal is burnt in an ordinary grate, and the heated air is brought in partly through the grate bars and partly over the bridge of the furnace. In the Ponsard furnace the air is heated in a somewhat similar way, but the ordinary fireplace is replaced by a gas producer, much after the form of Siemens.

At intervals of about half an hour the current is reversed in the Siemens furnace by reversing the valves so that the gas and air then pass up through the other pair of regenerators while the waste products pass through those just used for admission of gas and air.

The system of burning powdered fuel that has been worked out by Mr. Crompton gave great promise of success. By this plan the coal is ground to fine dust, passed through silk sieves, with thirty holes to the linear inch, and fed into the furnace at any required rate by a clever arrangement of mechanism. Air is supplied in measured and theoretical quantities from a fan blower. By this means intense heat is generated sufficient to melt steel. The plan has been applied to puddling furnaces, but one of the difficulties connected with the burning of coal-dust is that the ash melts and fluxes the sides of the furnace to a very serious extent. There can be no doubt that if, instead of attempting to use the commonest kinds of coal, Crompton had used the purest he could obtain, this difficulty would have been to a large extent obviated and better results would have followed. Although intense heat can be generated by the use of air there can be no reason why still better results should not be obtained by using heated air. As Crompton estimates that the cost of grinding and sifting the coal on the large scale can be effected for under 1s. per ton, and as a much larger proportion of the calorific power of the fuel could be utilised by this system than by any other, it does appear that the system ought to be used. One of the difficulties of preparing the coal is the necessity for drying it before sifting. It probably by using hot air larger particles of coal could be used and the difficulty got over.

Price's retort furnace is a further departure from Siemens' regenerative plan. In this the waste heat is partly used to heat up the air for combustion and partly to heat up the retort itself. The fuel, raw coal, is fed into a vertical retort, composed partly of cast iron and partly of firebrick, and from this it falls on to an inclined surface leading to the fire-grate. The products of combustion after circulating around a system of air pipes pass around the retort and heat up the fuel to a slight extent. This fuel is then pushed forward by a rabble on to the grate bars and is burnt by the current of heated air forced into a closed ashpit. Very high temperatures can be obtained by this means, sufficient indeed to melt wrought iron; but only certain kinds of coal work well in the retorts, and there is a good deal of trouble in getting it to feed regularly and in feeding the fire. By using a modification of this furnace with Gorman fire-clay tubes for regenerating the air a pretty successful steel melting furnace has been worked at Woolwich Arsenal, where there are several now in use.

A vast number of plans for saving fuel under boilers have been patented and tried, but so many of them have come largely into use. The Jukes travelling grate and its modification was at one time in considerable favour, but there is a good deal of difficulty in regulating the quantity of air employed, and unless any large excess of air can be prevented the cooling effect is more than counterbalances the saving. Something has been saved by a system of self-feeding hoppers, but even here the cost of repairs and loss from stoppages is very serious. An arrangement known as Frisbie's feeder appears to be one of the most satisfactory mechanical feeding arrangements. In this mode of feeding each charge of coal is put into a movable feeding box, which by a mechanical arrangement is then brought under the live coal, and the fuel is pushed up from below into the middle of the fire-grate. By this means the surface of the fire is always bright, and the products of distillation have to pass up through the red-hot fuel and are there consumed, thus avoiding smoke. It is said to give very satisfactory results when applied to boilers, glass furnaces, and puddling furnaces.

Great improvements have been made in open grates for domestic purposes. These have been made shallower than the older forms, and are now generally lined with firebrick. Blowers for feeding shutters are common, and the grates are made to project more into the room, thus obtaining more heating efficiency. Undoubtedly, the best grate for ordinary rooms is the

"Abbotsford." In this grate the sides and bottom are of fire-brick. The front projects well forward, the sides close in towards the back. A space is left between the hearth brick and the ornamental iron front for the admission of air and reception of ashes. The grate is very shallow, and while giving out a good heat burns very little coal.

In kitcheners many improvements have been made, the flues being better arranged, the fronts closed or open at pleasure, and other changes have been made which diminish the consumption of fuel and production of smoke.

The use of gas for heating and domestic purposes is still in its infancy. Many years ago Siemens proposed to manufacture a cheap gas for these purposes in his producers at the coal mines, and to convey it to towns in large mains, but so far the scheme, although clearly practicable and economical, has not been carried out. One difficulty connected with the use of producer gas for domestic purposes arises from its poisonous nature, carbonic oxide, which is its principal combustible constituent, being highly poisonous. Still this has not prevented the use of natural gas, which also contains a considerable quantity of carbonic oxide, and which is used under a much higher pressure than would be employed with "producer" gas. Various attempts have been made to use the so-called water gas, that is, a mixture of hydrogen, carbonic oxide, and nitrogen, produced by forcing steam through red-hot fuel; but so far this has not been economically successful. The only gas, therefore, at present available for heating purposes in towns is the ordinary illuminating gas. Notwithstanding its expense it has been found possible to employ this agent economically in various circumstances.

The first scientific attempts to define the rules applicable to the combustion of ordinary gas and air were made by Mr. Wallace, of Manchester. Considerable improvements upon the ordinary laboratory Bunsen burner were made by Mr. Wallace, but the most industrious and successful worker in this direction has been Mr. Thomas Fletcher, of Warrington. He has given the results of his researches in a paper read before the Gas Institute in 1883. This paper gives the laws relating to the forms and details of burners for heating purposes, and has led to their much more extended application. One of the features of his furnaces is the use of very light porous clay casings, which allow of the use of very simple forms of furnace. His furnaces urged with a blast the use of an injecting arrangement devised by Mr. Fletcher adds greatly to their efficiency while reducing their cost. For small metallurgical operations these furnaces are very handy and economical. These burners are applied to domestic fireplaces, cooking ranges, boilers, &c. By using a special burner ordinary kerosene and paraffin oil can be used in place of gas.

Petroleum and Mineral Oils.—These have come much more largely into use during the last twenty-five years, but mainly as illuminating agents. Their combustion, however, develops great heat, and being cheap they are often used merely as heat givers. One difficulty connected with their use for this purpose is that imperfect combustion gives rise to very unpleasant odours, but where combustion is perfect, as in a good Hink's, Silber, or Mitrailleuse lamp, considerable heat, as well as light, may be obtained at a small expense and in a very convenient way. The products of combustion, however, should, if possible, be carried off by special arrangement when large burners are used, although, from their freedom from sulphur, they are not nearly so deleterious as those of gas.

The enormous quantities of mineral oil obtained in various districts is most remarkable. The region around the Caspian Sea, known as the Baku district, is more than rivalling the United States oil regions in the apparently inexhaustible supply. In this district the Caspian Company have just made a boring 696 feet deep, into which a six and a-half inch pipe has been sunk, and the flow of naphtha equals 1600 tons, or 4 to 500,000 gallons. M. Debour, close to the above company, has a flow of 340 tons per day, whilst the Baku Company, with their 12-inch bore, are able to regulate the supply by a valve at the top of the bore, and can take up to 1,500,000 gallons per day.

Mineral oils obtained by distillation of coal shales has become a very important industry in Scotland, but the products are mainly used for illumination.

Quite recently the crude residue left after extracting oil from shale has been made use of for heating purposes by the contractors at the North Bridge. This residue has hitherto been a waste substance. It resembles coarse butter in appearance, and will not burn by the application of a match; but by melting the material, and forcing it in jets with superheated

steam against previously heated fireclay surfaces, with an induced current of air it burns freely and develops great heat.

The use of natural gas has quite recently become of great importance in particular localities. It has long been known that bore-holes in some coal-fields emitted continuous streams of combustible gas, and the first proposal to use gas for illuminating towns was made in the latter end of last century by the manager of the Whitehaven Collieries, who proposed to convey a blower of natural gas from his collieries in pipes for town use. At the present moment natural gas is being very largely used for manufacturing purposes at Pittsburg, in the States. So enormous is the supply, that it has already taken the place of coal in many of the large manufacturing works of the district.

The gas issues from strata at 1200 to 1500 feet below the surface, and when bore-holes are put down to this natural accumulation, it rises under a pressure of 150 to 200 lbs. per square inch. The first gas well of any note in this region was discovered at Murrysaville, a village about twelve miles south-west of Pittsburg. A company of oil seekers were boring for oil, but when they had reached 1200 feet they struck a blower of natural gas so strong that further operations were stopped. After serious disputes as to ownership, pipes were laid and the gas conveyed to mills in the neighbourhood.

The success and permanency of this application led to other wells being sunk in the neighbourhood, and quite recently to borings being put down in the town of Pittsburg itself. The first large well was struck by George Westinghouse (the inventor of the air brake) at Homewood, inside the city limits. The flow of gas through a $5\frac{1}{8}$ -inch casing is enormous. Many companies have been formed for supplying the gas, the most important being the Penn Company, with three wells at Murrysaville, eighteen miles from Pittsburg, supplying amongst others the Pittsburg Steel Casting Company; O'Hara Glass Company; W. Fisher, founder, for boilers; R. Munroe, boiler maker; Walker, Dunley, & Co., pork packers, for boilers; Frauenheim & Vilsack, brewers, for boilers; Schoenberger & Co., boilers, heating and puddling furnaces; Carnegie Brothers, & Co., boilers, heating and puddling furnaces; Hassey, Howe, & Co., open hearth furnaces; Park Bros. & Co., open hearth furnaces, &c., &c. Members of the same company own a dozen wells on Indian Creek, McKean County, Pennsylvania, which supply heat and light for Ollan, New York, the gas being mostly used in dwellings.

The Fuel Gas Company has a number of 6 in. and 8 in. mains, supplying mainly the glass works on the south side of Pittsburg. The Acme Company, with wells at Murrysaville, supply the Edgar Thompson Steel Works nine miles distant, and the Pittsburg Steel Works two miles further off.

The Washington Natural Gas Company are supplying gas from a point twenty-two miles from the city. Spang, Chalfant, & Co., whose rolling mill is at Sharpsburg, were the first iron manufactory in this vicinity to use natural gas. Their well, which was started in 1875, is still prolific. They have a number of other wells, some of which have become exhausted. It is supposed that some of these have been drained by the oil wells in the district. Enough has been said to show that natural gas is a fuel of considerable importance, and although its use is at present confined mainly to the district around Pittsburg, there seems to be no good reason why it should not be discovered in other localities. It must clearly derive its origin from the Carboniferous strata, and its proximity to the oil districts is remarkable. In the use of the gas very little attempt has so far been made to burn it scientifically. It is generally considered sufficient to bring the gas pipe under the boiler, &c., and make arrangements for admitting as much air as may be required to burn it.

GROUP XVI.
FUEL, FURNACES, &c.
EAST ARCADE.

[For Coke Ovens and Metallurgical Furnaces, see Group II.; for Glass, &c., Furnaces, see Group XXIII.]

1534. FLETCHER, THOMAS, Thynne Street, Warrington.—(1) Double Gas Service Tap. (2) Open-fire Gas Cooking Ranges. (3) Gas Fire and Circulating Boiler for kitchen. (4) Gas Furnace for laboratory. (5) Harness Room Gas Fire and Boiler combined. (6) Kitchen Gas Fire Oven and Boiler. (7) Coffee Roasters, internally fired.

1535. BROWN & GREEN, Finsbury Pavement, London, E.C.—New Church Stoves.

1536. CONSTANTINE, T. J., 61 Fleet Street, London, E.C.—Improvements connected with portable and other close ranges and stoves, and for furnaces of steam boilers, for the consumption of smoke therein, and a further improvement by which the fire space is modified by means of a rising grating for the purpose of concentrating and economising the fuel.

1537. PEARSON, R. H. & J., Notting Hill Gate, London, W.—(1) Kitcheners. (2) Register Grates.

1538. WILSON ENGINEERING CO., Limited, 227 High Holborn, London, W.C.—Cooking and Heating Apparatus.

1539. WALKER, ROBERT, 13 Buckingham Street, Adelphi, London, W.C.—Patent Hydro-Carbon Furnace and Apparatus for the generation of steam smelting of metals, and for the heating of ovens, &c., without smoke, sparks, or ashes, at any required temperature, and for any time.

1540. SOMERVILLE, JOHN, Gas Works, 70 Bankside, Southwark, London, S.E.—Patent Safety Gas Cooking Stove.

1541. HARRISON, GEORGE KING, The Lye Fire Clay and Brick Works, Stourbridge.—Patent Gas Retort in segments.

1542. STEEL & YARLAND, 45 Holborn Viaduct, London, E.C.—Wharcliffe Ventilating Grate.

1543. HALL, CHARLES EDWARD, Standard Iron Works, Sheffield.—A Patent Peat Condensing Machine.

1544. SIEMENS, FREDERICK [successor to the late **SIR WILLIAM SIEMENS**], 12 Queen Anne's Gate, London, S.W.—Improved forms of Regenerative Gas Furnaces and of Gas Producers, for

the manufacture of open-hearth steel and of glass in a continuous manner, and for other purposes.

1545. BOND, CHARLES ACTON, 67 The Grove, Hammersmith, London, W.—(1) The Eclipse Peat Fire Lighter. (2) Horses' Peat Moss Litter. (3) Peat Dust and Burning Peat.

1546. KINGSFORD, C., Lea Chemical Works, Hackney Wick, London, E.—Steam Boiler, combined with coke and other ovens, for utilising the heat hitherto wasted. This system can be seen in operation at the Exhibitor's works as above, and at other places.

1547. WARD, MRS. MARY, 107 Flood Street, Chelsea, London, S.W.—Thomas Baker's Patent Asbestos Gas Fire.

1548. PARTRIDGE, JOHN, 29 City Road, London, E.C.—Improvements in the method of packing and disposing fire material.

1549. TOMKINS, ALFRED S., Capt Victoria Rifles, Holmwood, Caterham Surrey.—Field or Camp Stoves for military cooking.

1550. CLARKE & CO., Forest Road Nottingham.—(1) Patent Perforated Furnace Bars. (2) Automatic Smoke Consumer [J. Butter's Patent].

1551. PAULSON, RICHARD, Boon Hills, Langwith, Mansfield.—Smoke-consuming and Fuel-economising Furnace.

BAXTER, CAPT. J. C., R.E., Colchester, Essex. (See Group XXV.)

BEILBY, GEORGE, Midcaldor, N.E. (See Group XXVIII.)

BLAKE, BARCLAY, & CO., Victoria Works, Greenock. (See Group XIV.)

BROWN, J. D., & CO., 49 Fenchurch Street, London, E.C. (See Group II.)

FAIRFAX, J. S., 3 Paul's Road, Camden Square, London, N.W. (See Group XV.)

HODGKINSON & CO., Limited, Ordsal Machine Works, Woden Street, Salford, Manchester. (See Group IV.)

JOHNSON, WILLIAM, Cardigan Works, Leeds. (See Group III.)

JUSTICE, P. S., & CO., 55, 56 Chancery Lane, London, W.C. (See Group II.)

KINGSTON, FRANK, 9 Bolden Street, St John's, Deptford, Kent. (See Group X.)

KIRKALDY, JOHN, 40 West India Dock Road, London, E. (See Group IV.)

KNOWLES, H., Albion Works, Woodville, Burton-on-Trent. (See Group XXIII.)

MUNICIPAL APPLIANCES CO.,
Limited, 37 Victoria Street, Liverpool.
(See Group III.)

PARTRIDGE, JOHN, 29 City Road,
London, E.C. (See Group III.)

**ROCKING FIRE BAR SYNDI-
CATE**, Limited (**THE**), 259 Gresham
House, Old Broad Street, London, E.C
(See Group IV.)

ROWELL, G., M.D., Falcon Road,
London. (See Group XXV.)

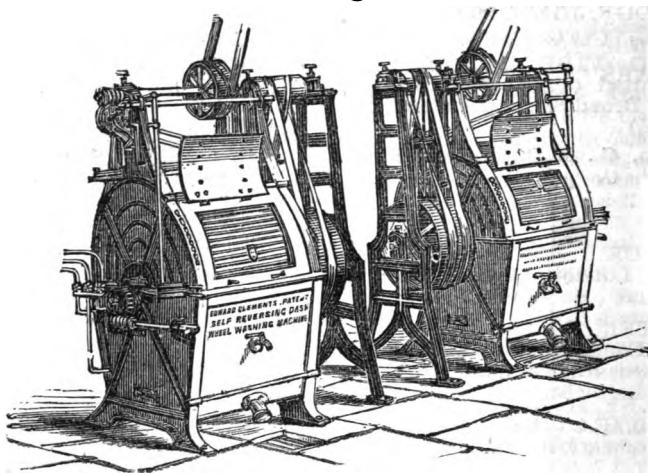
TYLER, HAYWARD, & CO., 84
Whitecross Street, London, E.C. (See
Group IV.)

WILLANS & ROBINSON, Ferry
Works, Thames Ditton, Surrey. (See
Group IV.)

**YOUNG, WILLIAM, & G
BEILBY**, Priorsford, Peebles, and
Midcalder, N.B. (See Group XV.)

Steam Washing Machines.

CLEMENTS'
PATENT SELF-REVERSING

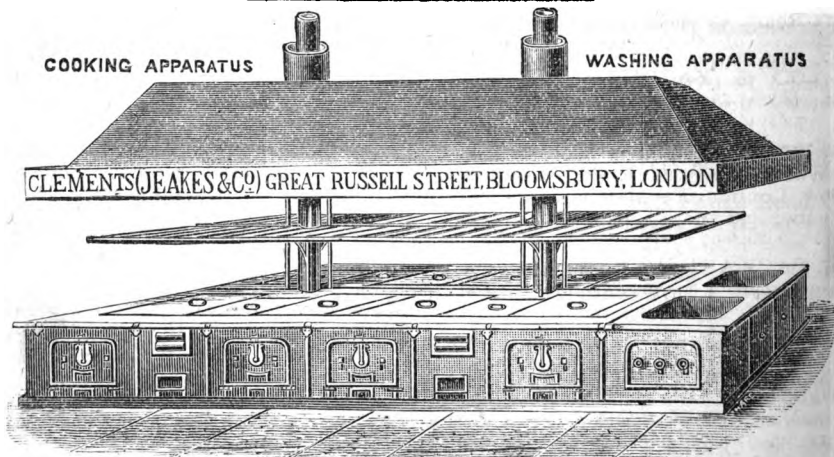


STEAM
WASHING MACHINES.

CLEMENTS' PATENT,

For Hospitals, Workhouses, Asylums, Infirmarys, &c.
Will wash cleaner, at less cost and less time than any other Machine.

CLEMENTS (JEAKES, & CO.) Laundry & Cooking Engineers,
51 Great Russell St., Bloomsbury, London, W.C.



*See the two great Cooking Apparatus at work, South Side of Dining Room,
50 feet long (the largest ever made).*

Made by **CLEMENTS (JEAKES & CO.)** Cooking Engineers,
51 Great Russell St., Bloomsbury, London, W.C.

GROUP XVII.—FOOD, COOKERY AND STIMULANTS. EAST ANNEXE.

[For the Cooking of Cattle Food, see Group I.]

1555. **SHEARS, J., & SONS, Bankside, Southwark, London, S.E.**—Patent Centrifugal Sugar-drying Machine, with suspended drum and bottom-discharging valve, with its combined steam-engine, continuous discharging vacuum pan for continuously evaporating and discharging saccharine and other fluids.

1556. **ALRICK, L., & CO., 27 Leadonhall Street, London, E.C.**—Hermann's Patent Malt Kilns.

1558. **CARTER, J. HARRISON, 82 Mark Lane, London, E.C.**—Carter's Controllable Automatic Roller Milling System.

1559. **POOLEY, H., & SON, 89 Fleet Street, London, E.C.**—Automatic and other machines for weighing grain.

1560. **ARABIAN COFFEE CO., 42 Abchurch Lane, London, E.C.**—The Infinitum [Combination Coffee Roaster, Grinder, and Brewer].

1561. **BOLTON & PARTNERS, Limited, Lavenham Works, Suffolk; and The Sanctuary, London, S.W.**—Treatment of saccharine juices and manufacture of pills of strontium for a production of refined sugar direct from the beets.

1562. **MASON, GEORGE, & CO., 417 Chelsea Road, Chelsea, London, S.W.**—(1) Essence of Beef, Veal, Mutton, and Chicken. (2) Turtle Soup for invalids. (3) Concentrated Beef-Tea. (4) Beef-Tea Jelly. (5) Savoury Meat Lozenges. (6) Ossiferous Pills. (7) O.K. Sauce.

1563. **WEST, T., & CO., Bromley Engine Works, Devon's Road, Bromley-by-Bow, London, E.**—Machine for milling, decorticating and scouring rice, popper, barley, and other grains and seeds.

1564. **PACKARD, E., & CO., Ipswich.**—Improvements in the manufacture of sugar cane juice.

1565. **DUNLOP, ROBERT, 41 Oakfield Street, Cardiff.**—Patent Air-tight Fountain or Vat for preserving, in good condition, wine, ale, and other liquids; also vessels for preserving in liquid pickles, preserves, meat, &c., in an air-tight condition.

1566. **HEDICKE, M., & CO., 3 Adelaide Place, London Bridge, London, E.C.**—(1) Grain Balance, for ascertaining from a sample of grain the weight per bushel or any other measure. (2) Quick Germinating Apparatus, for testing the germi-

nating capacity of barley, and ascertaining the percentage of its value for malting.

1567. **BURROW, W. & J., 15 Seething Lane, London, E.C.**—(1) Iron Wine Bins. (2) Wine Still. (3) Corking and Bottling Machines. (4) Hydrometers. (5) Brewers' Thermometers, Saccharometers, and other instruments and appliances connected with the manufacture and use of alcoholic drinks.

1568. **LANGTON, ROBERT, SON, & CO., 9 King Edward Street, London, E.C.**—(1) Improvements in luncheon, shooting and picnic baskets; also specimens of improved covering for tumblers and bottles. (2) Camel equipped with outfit of camel corps.

1569. **FORDRED, JOHN, 4 Union Court, Old Broad Street, London, E.C.**, Inventor and Patentee.—(1) Series of Malted Food Preparations:—[a] Allen & Hanburys' Malted Farinaceous Food and Malted Jelly. [b] Hill & Sons' Malted Nursery Biscuits. (2) Series of Torrefied Grain, with model:—[a] Barley, Maize, Rice, &c., for brewing, distilling, and vinegar making. [b] Maize prepared for horse and cattle food by the Torrefied Grain Company. (3) Spencer, C., & Sons' [Stansted, Essex] Malted Cake for cattle feeding.

1570. **TOMKINS, COURAGE, & CRACKNALL, 61 Mark Lane, London, E.C.**—Kiln for drying malt and all kinds of cereals.

1581. **FREE, ROBERT, The Elms, Mistley, Essex.**—(1) Patent Kilns for drying malt, grain, hops, and other produce. (2) Patent Steeping Tanks, employed in the manufacture of malt.

1582. **MALEN et DÉGLIES, 6 Rue Oberkampf, Paris (Agents, E. SALAMAN & CO., 3 Cross Lane, Eastcheap, London, E.C.)**—Apparatus for making tea and coffee, &c.

1583. **STOPEs, H., & CO., 24a Southwark Street, London, S.E.**—(1) Improvements in malt kilns, in many details, chiefly connected with the successful use of double drying floors and the Stopes' system of malting. (2) Improvements in the cleaning and purification of barley and malt.

1584. **CLARKE, MRS. C., National Training School of Cookery, South Kensington, London, S.W.**—Tea and Coffee Urns.

1585. **CLOWES, E. A., Stamford Street, London, S.E.**—Patent Shrapnell Folding Table and Seats.

1600. **WALSH, J. E., Waterhouse Chambers, Crossley Street, Halifax; and 8 Quality Court, London, W.C.**—Improvements in self-regulating feeds, for rollers and purifiers for milling and other purposes.

1601. **WARNER, J., & SONS**, Crescent Foundry, Cripplegate, London, E.C.—Improved Hop-washing Machine.

1602. **WRIGHT, J. P.**, 26 Colliergate, York.—Models of churns and appliances used in the manufacture of butterine.

1603. **PARNALL, WILLIAM**, 108 Victoria Street, Bristol.—Tea Blending Machine.

1604. **LEVETT, W.**, Glassenbury, Cranbrook; & **ARNOLD, W.**, Frant, Tunbridge Wells.—Steam [or other] Power Hop-washing Apparatus, for destroying aphides.

1605. **BOYS, C. V.**, Physical Laboratory, Science Schools, South Kensington, London, S.W.—Apparatus for testing the condition of eggs.

1606. **BLACK, JAMES**, 73 Irish Street, Dumfries.—Grain Drying Machine.

1607. **SQUIRE, W. S.**, 37 Acacia Road, Regent's Park, London, N.W.—Process for the manufacture of pressed yeast, for bread-making and confectionery.

1609. **EDMUNDS, J.**, 10 Stonefield Terrace, Liverpool Road, London, N.—A New Table Bottle, filled with "The Favorite," "The Empress," and other chutneys. This bottle is fitted with two corks, specially arranged for packing; and when one cork is removed, a glass top lined with cork forms the cover, so as to be used at table.

1610. **GRIFFIN, SAMUEL**, Kingston Iron Works, Bath.—Patent Yeast Sluice or Self-acting Skinning Apparatus.

1611. **LAING, WILLIAM**, 89 Whitburn Street, Sunderland.—(1) Sun and Planet Boundabout. (2) Cask Washing Machine.

1612. **HALL, C. E.**, Standard Iron Works, Sheffield.—Chilled Roll suitable for roller milling machines.

1613. **WOOD, JAMES P.**, 324 City Road, London, E.C.—An Improved Cabinet with invisible cupboard.

1614. **FRY, J. S., & SONS**, Union Street, Bristol.—(1) Malted Cocoa and Chocolate. (2) Soluble Cocoa. (3) Ceylon Chocolate.

1615. **MARSHALL, A. B.**, The School of Cookery, 30 Mortimer Street, London, W.—Improvements in freezing machines and in ice caves for moulding and keeping ices, the latter being also applicable for keeping food at a high or low temperature for long periods.

NELL, F., 16 Mark Lane, London, E.C.—Roller Mill used in the gradual reduction of wheat into flour. This mill where so used is supplied with fluted rolls, the smooth

rolls only being used for the reduction of semolina or middlings.

COPPARD, J., 85 Holloway Road, London, N.—(1) Patent Excelsior Bottle Opener. (2) Improved Excelsior Champagne Tap. (3) Patent Improved Folding and Self-tilting Cask Stand. (4) Improved Adjustable Trivet for fire-grate bars. (5) Patent All-iron Champion Sausage-making and General Mincing Machine. (6) Portable Roughing for horse-shoes.

THORNEWILL & WARHAM, Burton-on-Trent.—(1) Triple disc Machine for washing casks, with vertical engine for driving. (2) Model Steam Pump, with phosphor bronze valves. (3) Improved Frictional Hoist, to lift 4 cwt.

GREIG, J., & CO., Regent Works, Regent Road, Edinburgh.—(1) Patent Economic Tea Leaf Withering, Drying, and Winnowing Machine combined. (2) Patent Green Tea Leaf Equalising Machine. (3) Patent Economic Continuous or Globulous Pipe Fruit, Tea, or Grain Drying Stove.

BINDLEY & BRIGGS, Burton Copper Works, Burton-on-Trent.—(1) Patent Refrigerators, for cooling brewers' and distillers' worts, milk and other fluids. (2) Patent Mashing Machine. (3) Patent Cask Plugs or Stoppers. (4) Improved Gun-metal, India-rubber Face Valves.

RIGG, J., 11 Queen Victoria Street, London, E.C.—Rigg's Patent Flooding Elevator, for loading grain, coal, and other substances, from lighters into vessels, or on quays at a higher elevation.

ARUNDEL & CO., Bromley Street Works, Ashley Lane, Manchester. (See Group IV.)

AVERY, W., & T., Digbeth, Birmingham; and 14, 15 & 16 Cross Street, London, E.C. (See Group XI, Queen's Gate Annexe.)

BAXTER, CAPT. J. C., R.E., Colchester, Essex. (See Group XXV.)

DICKSON, WILLIAM, Quartermaster 24th Middlesex R.V., Post Office Regiment, 14 Old Change, London, E.C. (See Group XXV.)

FOULIS, J., 28 Market Place, Musselburgh, Midlothian, N.B. (See Group XI.)

MACLEOD, MALCOM, 66 Deansgate, Manchester. (See Group III.)

PACKARD, EDWARD, & CO., Ipswich. (See Group XIV.)

PRICE, JOSEPH, & CO., Brunswick Foundry, 39 & 41 Sefton Street, Liverpool. (See Group IV.)

REYNOLDS, F. W., & CO., Acorn Works, Edwards Street, Blackfriars Road, London, S.E. (*See Group I.*)

SCHULTZ, J. C., 1 Laurence Pountney Hill, London, E.C. (*See Group XXII.*)

SHARMAN, JOHN, 81 Liverpool Road, Islington, London, N. (*See Group III.*)

STEWARD, JAMES HENRY, 406 Strand, London, W.C. (*See Group XXVIII.*)

SUGG, WILLIAM, & CO., Limited, Vincent Works, Westminster, London, S.W. (*See Group XV.*)

WATSON, LAIDLAW, & CO., 98 Dundas Street, Kingston, Glasgow. (*See Group IX.*)

ANDERSON, ANDERSON, & ANDERSON,

LATE

ANDERSON, ABBOTT, & ANDERSON,
India-Rubber and Oilskin Manufacturers.

37, QUEEN VICTORIA STREET, LONDON, E.C.

Gold Medal, Amsterdam, 1869.
Gold Medal, South Africa, 1877.
Gold Medal, Paris, 1878.



CONTRACTORS TO THE
Rt. Honorable the LORDS
COMMISSIONERS OF THE
ADMIRALTY,
THE WAR OFFICE,
The Secretary of State for India,
LONDON METROPOLITAN POLICE,
AND THE
London Metropolitan Fire Brigade.

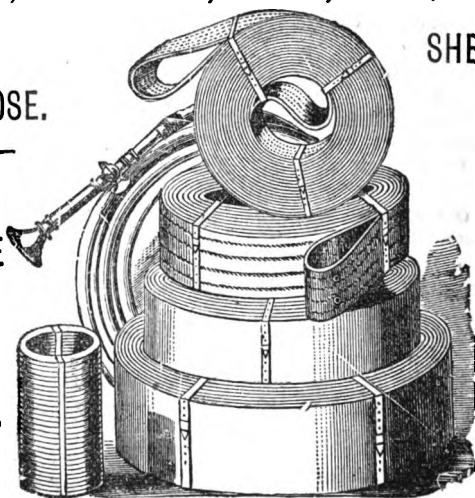
Silver Medal, Melbourne, 1881.
Gold Medal, Fisheries Exhibition,
1882.
Gold Medal, Calcutta, 1883-4.

Driving Belts, India-Rubber, Leather, Cotton, Gutta Percha.

WOVEN
CANVAS HOSE.

DELIVERY &
SUCTION HOSE

INDIA
RUBBER MATS.



SHEET RUBBER.

WASHERS.

BUFFERS.

VALVES.

PACKING.

TANNED CANVAS FIRE HOSE, RUBBER LINE

Same as supplied by us to the London Metropolitan Fire Brigade.

From THE TIMES, Dec. 5th, 1879:—"Yesterday the leather hose of the Metropolitan Brigade was given up in favour of a new tanned canvas hose lined with india-rubber, about 80,000 ft. of which has been manufactured for the Brigade by the inventors, Messrs. Anderson, Abbott, and Anderson. The new hose was tested up to 300 lb. pressure on the square inch, and, with the exception of one short length, all was accepted. The new hose has the advantage of being waterproof, and can convey water through a warehouse or room without damage by leakage to the goods. It is claimed for it that it is cheaper, lighter, and stronger than leather hose, will not require so much labour to convey it to the hydrants, does not need dressing to keep it in order as leather does, and is not so liable to be burnt. Captain Shaw was yesterday present at the testing of the hose, and expressed himself perfectly satisfied with the new material."

37, QUEEN VICTORIA STREET, LONDON, ENGLAND.

GROUP XVIII.—CLOTHING.

EAST QUADRANT.

For Textile Machinery, see Group IX.; for Jewellery, &c., see Group XIX.; for Waterproof Clothing, see Group XXI.]

1616. GRIFFITH, C. J., 106 Olinda Road, Stamford Hill, London, N.—Spring for sewing machines.

1617. RANDALL, H. E., Ladies' Lane, Wood Street, Northampton; and 6 Romile Street, London, E.C.—The famous Lawn Tennis and Athletic Shoe, India-rubber soles of which are stitched on a new process, which prevents slipping or coming off.

1618. WINTER, S., 9 & 11 Sussex Lane, Queen's Gate, South Kensington, London, S.W.—Improvements in the manufacture of boots and shoes, used for tennis, bag, cricketing, and other athletic sports.

1619. HARRIS, H., 56 St. Michael's Road, Northampton.—(1) Solid Leather [Lawn Tennis]. (2) Popham's Patented Sewal Seam.

1620. DENT, ALLCROFT, & CO., 97 Wood Street, London, E.C.—(1) Circular Rings for gloves, cuffs, and gauntlets. (2) Snap Fasteners for gloves.

1621. GIBUS, M., 8 and 10 Chandos Street, Trafalgar Square, London, W.C.—Patent Automatic Opera Hat Machine.

1622. BULMER, J., West Field House, Healey, near Leeds.—Boot-making and Finishing Machine.

1623. HOWELL & JAMES, Limited, 7, 9 Regent Street, W.; and 10 Charles Street, St. James', London, W.—The Queen Victoria Alpaca-Mohair, a material for ladies' and children's dresses, manufactured in England from the finest Mohair.

1624. BRADBURY & CO., Limited, Collington Works, Oldham, near Manchester; and 14 Newgate Street, London, E.C.—(1) The Rotary Shuttle Sewing Machine. (2) Family and Medium Sewing Machines. (3) A Repairing Machine for Shoes. (4) Practical Hatter Machine, for making silk and felt hats.

1625. JONES, T. O., 149 Brooke Road, Upper Clapton, London, E.—Patent Combination Boot and Shoe Cleaning, Blackening, and Polishing Machine, for household and street purposes.

1626. THOMAS, W. F., & CO., 48 Holborn Viaduct, London, E.C.—Patent and Improved Sewing Machines.

1627. TAYLOR, J. R., Kingswinford, Dudley.—An Improved Washing Machine made of wood and zinc.

1630. HEATH, HENRY, 105, 107 & 109 Oxford Street, London, W.—Hat Makers at work, exhibiting the various processes in the manufacture of Soft-fitting Consolidated Silk Hats, viz.—(1) From the calico foundation to the complete silk covered hat. (2) The manufacture of silk hats on cork bodies. (3) The manufacture of opera folding hats.

1631. NORTHAMPTONSHIRE AND LEICESTERSHIRE BOOT AND SHOE MACHINERY CO., Limited (THE), 28 Friar Lane, Leicester.—(1) Cutlan's Patent Heel Attaching, Pareing, and Breasting Machine. (2) Patent Heel Building Machine.

1632. TURNER, R., & SONS, Old Factory, Redditch.—Wire-drawing Apparatus, with products of same in pins, brass and steel, needles of all kinds, &c.

1633. WARWICK, J., 59 Hilton Street, Manchester.—Warwick's Patent Oscillating Motion, applicable to all kinds of machinery in which a reciprocating or oscillating motion is required.

1634. UNICUM PATENT AUTOMATIC BUTTON-HOLE MACHINE CO. (THE), 81 Paternoster Square, London, E.C.—Patent Automatic Button-hole Cutting and Sewing Machine.

1635. SALMON & CO., Victoria Works, Kettering, Northamptonshire.—(1) New Patent Machines for heel building and toe-piece rivetter combined, heel attacher and breaster combined, improved eccentric sole-cutting press, combined split lift and ranger, toe-cap perforating machines, eyeletting, hooking and punching machines, patent self-feeding eyeletting machine, iron lasts, sole and heel cutters. (2) Grindstones for engineers, electricians, &c.

1636. HOWE MACHINE CO., Limited (THE), Factory, Glasgow.—Sewing Machines for family and trade uses. The original Elias Howe model, and the latest improvements thereon.

1637. TROTMAN, H., 228 Euston Road, London, N.W.—Permanent Accordion Pleating Machine.

1638. SHEPHERD, ROTHWELL, & HOUGH, Oldham Sewing Machine Works, Oldham.—(1) Sewing Machines having equal motions so that it will sew forward and backward. (2) Circular Knitting Machines, in which different sizes of cylinders can be used.

1639. POCOCK, BROS., 235 Southwark Bridge Road, London, S.E.—(1) Solid Leather Toe-Tips. (2) Hygiene Self-ventilating Sock. (3) Machines used in their manufacture. (4) Patent Beds for invalids, with working models.

ANDERSON-LAING, S. J., Slitrig House, Hawick, Roxburghshire. (*See Group IX.*)

ARUNDEL & CO., Bromley Street Works, Ashley Lane, Manchester. (*See Group IV.*)

BARLOW, ROBERT, Norfolk House, Dalston, Middlesex. (*See Group XXIV.*)

BRIERLY, JOHN HENRY, 58 & 59 Aldermanbury, London, E.C. (*See Group IX.*)

CHEMICAL PAPERS CO., Limited, (THE), 3 Lombard Court, London, E.C. (*See Group XIV.*)

COKE, ARTHUR, 339 Oxford Street, London, W. (*See Group XXII.*)

KIRKCALDY, JOHN, 40 West India Dock Road, London, E. (*See Group IV.*)

MC NARY MACHINES CO., Limited (THE), 69 Lombard Street, London, E.C. (*See Group IX.*)

STANDARD MANUFACTURING CO., Strand Arcade; and St. Alkmund's Churchyard, Derby. (*See Group XXIV.*)

TURNER, M. A., & CO., 14 Gladhow Terrace, South Kensington, London, S.W. (*See Group IX.*)

WARD, CHARLES JAMES B., Mitre Road, Ridley Road, Rochester (*See Group VI.*)

GROUP XIX.—JEWELLERY.**SOUTH CENTRAL GALLERY.**

1642. **HANCOCK & CO., 39 Bruton Street, New Bond Street, London, W.**—(1) Manufacture of Jewellery. (2) Silver Plate. (3) Jewellery and Precious Stones.

1643. **GIULIANO, CARLO, 115 Piccadilly, London, W.**—(1) The introduction of open Arabesque work in gold and enamel. (2) Adopting the cutting of the stone in the natural form of its crystal.

1644. **HIRST BROS., 13 Arlington Street, Myddelton Square, Clerkenwell, London, E.C.**—Automatic - closing and Double-snapping Bracelet.

1645. **WARNER, MRS., 7 Pelham Place, South Kensington, London, S.W.**—Galactoid.

1646. **WALDEMAR, LUND, & CO., 51a Hatton Garden, London, E.C.**—Aureborean Manufacture of Shirt Studs, Collar Studs and Solitaires, in plain and engraved gold and real stones.

1647. **JONES, G., & SONS, 62 St. Paul's Churchyard, E.C.; & 368 Holway Road, London, N.**—Patent Safety Bracelet Snap.

1648. **WEST, WILLIAM, 42 Caroline Road, Birmingham.**—(1) Improvements in Solitaires and other dress fastenings. (2) Im-

provements in bracelet fastenings. (3) Improved Scarf Ring. (4) Improvements in brooch fastenings. (5) Improved Sleeve Links.

1649. **ABERLIN, H. W., 178 Regent Street, London, W.**—Improvements in clasps and rings for neckties and scarves; also Tie Retainer for white ties or any narrow tie; also for sailors' knots and pin scarves.

1650. **HIRST, GODFREY, 1 Cleveland Villas, Whitby.**—A new and improved method of manufacturing jet ornaments.

1651. **GRAY, E., & SON, 47 Clerkenwell Green, London, E.C.**—(1) Improved Flatting Mills for goldsmiths and jewellers. (2) Silent Running Lathes for scratch-brushing and polishing.

1652. **PARKES, A. E., 46 Warstone Lane, Birmingham.**—An Alloy of Black Silver, for inlaying purposes, to supersede Niellowork.

1653. **TREE, J. J., 38 Jewin Street, London, E.C.**—Special features of utility and novelty in collar studs, shirt studs, solitaires, bracelets, brooches, watch keys, and pencil cases.

COBBETT, W. W., 82 Southwark Street, London, S.E. (*See Group IV.*)

CROOKES, WILLIAM, 7 Kensington Park Gardens, London, W. (*See Group XIII.*)

GOLDSMITHS AND SILVER-SMITHS MANUFACTURING CO. (THE), 112 Regent Street, London, W. (*See Group XXVII.*)

ANDERSON, ANDERSON, & ANDERSON,

Late ANDERSON, ABBOTT, and ANDERSON,

INDIARUBBER, & OILSKIN MANUFACTURERS,

37, QUEEN VICTORIA STREET, LONDON, E.C.

OILSKIN POLICE CAPES.



BEST QUALITY OILSKINS AND SOUWESTERS.

LEATHER, &c.

By H. Y. DENT, F.C.S., F.I.C.

LEATHER consists of the skins of animals which have been so prepared (whether by tanning or otherwise) that they are rendered soft and pliable when dry, and have no longer any tendency to undergo putrefaction when placed under such conditions as would render them liable to decomposition in their natural state.

The early history of the manufacture of leather is very obscure, and the precise nature of the material alluded to as leather by ancient writers is uncertain, the original words used being applicable to any description of prepared skins.

The straps found in the wrappings of a mummy show that the material was known to the Egyptians, and it is evident that the Romans must have attained to a considerable knowledge of the art of tanning, since Pliny describes hides as being tanned with bark, nut galls, and sumach, and we have evidence of their skill in the ornamental shoes and boots worn by the Roman ladies.

Several centuries appear to have elapsed without any advance of consequence being made in the manufacture of leather. We find in the fourteenth century ornamental embossed leather manufactured in Spain, Italy, Flanders, and England, being used as tapestry, but this branch of industry was subsequently neglected without any attempt being made to revive it until a comparatively recent date. The first English patent for tanning was taken out in 1627, and was followed by others in 1635 and 1660. Improvements in the manufacture of leather were retarded for many years by the imposition of vexatious duties, the tax on leather not being abolished until the year 1830, and by the annoyances arising from tanneries being subjected to the inspection of the exciseman.

It was not until the beginning of the present century that scientific men began to devote their energies to the investigation of the true nature of the changes which take place during the process of tanning, the leather manufacturer having been left to his own resources and powers of observation in attempting to carry out improvements, or in discovering any new process.

The attention of chemists has, for some years past, been directed to this subject with considerable success, although it must be admitted that their efforts have not been rewarded with any such brilliant results as have attended their exertions in regard to many other manufacturing operations. Scarcely any entirely new process of converting skins into leather has been successfully carried out, the improvements that have been effected having chiefly consisted in shortening the time expended in conducting the proverbially slow process of tanning by adopting new methods of preparing the tanning liquors, and by making use of better appliances for cleaning and preparing the hides, which renders them less liable to injury and facilitates the absorption of the tannin. It is generally admitted that the quality of the leather now produced as regards toughness and durability is certainly not superior to that manufactured fifty years ago by the old process of tanning with oak bark. The stoutest and best hides are those imported from the River Plate in South America, which having been salted and dried, require to be brought back to the condition of fresh hides by steeping them in water to which is sometimes added brine, borax, or carbolic acid, in order to prevent the hide being injured by the long soaking which is necessary to soften it.

The depilation of hides by liming is one of the oldest methods known of loosening the hair, and is still extensively practised. The hides, however, are not now kept for so long a time in the liming liquor as was formerly the case, since it has been shown that the lime may act injuriously upon the hide. The object to be attained by this operation consists in the saponification of fatty matter and in the softening of the epidermis so as to allow of the hair being easily removed as well as the fleshy particles on the inner surface of the hide. Depilation is also promoted by what is termed "sweating," which consists in subjecting the hides to a slight putrefactive fermentation by which the cuticle, carrying the hair with it, becomes

softened so as to be capable of being easily detached. This process involves some danger of injury to the skin, unless care be taken to arrest the operation as soon as the required effect has been produced. Sugar, caustic soda, borax, calcium sulphide, and sodium sulphide, more especially the last, have been successfully employed as depilatory agents. A similar effect is also produced upon the hides by placing them in a revolving cage, the lower portion of which is immersed in water, the hides being thus exposed to the action of air and water alternately. The removal of the lime left in the hides is effected by soaking in water and immersing in weak acid solutions. In undergoing this treatment, which is technically known as "raising," the skin becomes dilated, and is thereby brought into a condition in which it is more readily acted upon by the tanning liquor. With the same object, and also to increase their softness and flexibility, the lighter descriptions of skins are subjected to a process termed "bating," which consists in exposing them to the action of the excrement of dogs and fowls, for which unsavoury mixtures various substitutes have been proposed, such as carbonate of ammonia, glucose, and weak acid solutions. Dilute hydrochloric acid has been successfully adopted by some tanners.

Tannin or tannic acid is the name given to a powerfully astringent vegetable principle obtained from different plants, and from different parts of the plants, which possesses the property of precipitating gelatine from solution and forming with it an insoluble compound. The character and quality of tannin depends upon the source from which it is obtained, and the condition in which the materials yielding the tannin have been collected, exposure to rain exerting an injurious effect upon the tannin they contain. The number and variety of the materials imported for the sake of the tannin they yield has been of late years greatly increased, and instead of being limited to oak bark, nutgalls, sumach, and a few others, as was at one time the case, the tanner has now at his disposal more than a hundred different varieties of material that are capable of being used as sources of tannin. The variation in the proportion and quality of the tannin they severally yield is considerable. Much attention has been paid during the last twenty-five years to the examination of these substances, and improved methods of estimating the amount and quality of the tannin they can severally be made to yield have been elaborated.

The most valuable of these materials is undoubtedly oak bark, although there are others which yield a larger amount of tannin, and the following may be regarded as being amongst those which are of the greatest commercial importance:—

Valonia, which is the cup of an acorn imported from the Levant.

Myrabolams, the dried fruit of an Indian shrub.

Nutgalls, the excrescences found on a species of oak growing in Asia Minor.

Dividivi, the seed-pod of a South American leguminous plant.

Sumach, the powdered leaves and young branches of a shrub growing in the south of Europe.

The material known by the names of Catechu, Gambier, and Terra Japonica, consists of the dried extract prepared from the wood and leaves of acacias and other trees growing in the east.

In tanning heavy sole leather upon the old system, which required a period of eighteen months, and sometimes much longer, to accomplish, the hides, after being brought into a proper condition to receive the tanning liquor, were placed in a pit with ground bark in alternate layers, in which they were left for a few weeks, and then transferred to other pits, this operation being repeated with supplies of fresh bark until the hides were converted into leather. The pits were in some cases filled up with soft water or weak infusions of bark, stronger solutions being employed during the latter part of the process.

The attempts that have been made with more or less success to reduce the time formerly required for the production of leather are very numerous. Tanning extracts are now employed to a very large extent instead of oak bark, and various salts and weak acids are employed which are either used separately or mixed with the tanning liquor, such as alum, common salt, soda, ammonium chloride, chromate of alumina, pyroligneous acid, and weak hydrochloric acid, for the purpose of opening the pores of the skins and facilitating the absorption of the tannin. For promoting the rapid tanning of skins, a method has been proposed for maintaining a continuous flow of the tanning liquor through the pit, and another for placing the skins together with the tanning liquor in rotating drums, the interior of which contain projecting ribs which exert a beating action upon the hides. Processes have also been devised for forcing the liquor into the hides by pressure, which are differently carried out. The skins are so arranged upon frames as

to form watertight bags which are filled with the tanning liquor from a cistern above, or they are suspended in air-tight vessels from which the air is exhausted, and in other processes they are placed in tanks capable of bearing a pressure of ten or twelve pounds per square inch, connected with hydraulic pumps.

It is stated, that by some of the quick tanning processes adopted, a very fair-looking heavy leather can be produced in from five to ten weeks. Excellent leather no doubt may be produced in a shorter time than was formerly considered necessary, but leather prepared in such a rapid manner as that stated, to meet the demands for a low-priced article, can never compete in quality with leather that is manufactured by slower methods.

With reference to rapid methods of tanning heavy hides, it must not be forgotten that the use of strong infusions of tannin in the early stages of the operation have a tendency to close up the pores of the skin, and prevent the interior portions of a thick hide from being properly tanned, and also that in the old slow method of tanning, the skins absorbed other extractive matter from the bark besides tannin, which add to the valuable properties of the leather produced.

The tanning of some of the lighter descriptions of leather is much more readily effected. Morocco leather is made from the skins of goats and sheep, which, after being soaked, limed, and otherwise prepared for receiving the tanning liquor, are sewn into bags, which are filled with a strong solution of sumach, and thrown into a tub of warm water containing a little sumach, in which the floating bags are rolled about for a few hours, by which time, the skins being very thin, they are sufficiently tanned for the purpose for which they are required.

Some kinds of leather are not tanned, but are prepared by other processes. The skins of calves, kids, lambs, and sheep, are prepared for glove-making purposes by "tawing," the action of which is to combine a salt of aluminium with the gelatine of the skin. The skins after tawing and liming are placed in what is termed a "bran drench," in order to open the pores and remove the lime. This bran drench consists of a sour mixture of bran and water, which has been allowed to undergo the acetous fermentation. They are then steeped for a few minutes in a solution of alum and salt, dried, and stretched. The skins required for making the finest qualities of leather are softened by being kneaded with a mixture of flour, water, and yolk of eggs, worked up into a thin paste.

Other descriptions of leather are prepared with oil only, cod oil being the description that is best suited for this purpose.

Shamoy or chamois leather, originally obtained from the skins of the chamois, is now largely prepared from sheep skins, or from the flesh side of sheep skins that have been split by machinery, and hence termed "flesh splits."

After the usual preliminary operations, the skins are scraped or "frized" on the flesh side with a round knife, steeped in sour bran, and after having been pressed as dry as possible, are ready to receive the oil which is forced into the skins by means of fulling stocks. The stocks work in a trough into which the oiled skins are placed, and beaten with heavy wooden hammers, fresh oil being added from time to time until a sufficient amount has been absorbed. They are then steeped in a weak alkaline solution to remove the excess of oil and dried.

The stout buff leather used for soldiers' belts is prepared in a similar manner, the excess of oil being squeezed out by hydraulic pressure.

Many attempts have been made to find some substitute for tannin in the manufacture of heavy sole leather, which have been for the most part based upon the fact that certain salts, such as alum and iron sulphate, form insoluble compounds with gelatine, but have been attended with little success, with the exception of what is known as the chromate process.

The hides, after being prepared in the usual manner, are placed in a pit containing a weak solution of potassium dichromate, alum, and sodium chloride, and are afterwards transferred to other pits containing stronger liquors. The astringent action of strong liquors, if applied at once to the hides, would, as in the case with tanning liquors, cause the surface of the hides to be drawn or wrinkled. After removal from the pits they are immersed in a solution of barium chloride, in order to neutralize the action of any potassium dichromate that may be remaining in the hide; they are then passed through clean water and dried. The action is very rapid; heavy hides for sole leathers are finished in three or four weeks instead of requiring from six to eight months, as is the case with ordinary tanned leather. They are then treated with paraffin,

wax, and resin, which are introduced in such a manner as to secure the penetration of these substances through every portion of the hide. Leather is made by this process on a considerable scale in Glasgow, which is reported to be of excellent quality, and produced at a less cost than by the ordinary tanning process.

An artificial leather, known as vegetable leather, is prepared by coating with mucilaginous substances sheets of carded wadding (made from cotton waste) placed on hot metal plates, which are afterwards passed between hot metal cylinders, and coated with linseed oil and vegetable wax. Artificial leather is also made by coating some woven texture or paper with a flexible oil varnish in various colours. The strength of such material is increased by stout backings of linen cemented with caoutchouc, and a very strong useful substitute for leather is produced at one-third the cost of real leather.

GROUP XX.—LEATHER, &c.

(EAST QUADRANT.)

[For Saddlery, see Group VI.; for Boots and Shoes, see Group XVIII.]

1663. SOMERVELL BROTHERS, Netherfield, Kendal.—(1) Waterproof K Boots. (2) Anhydrous Waterproof Leather, of various descriptions for the boot and shoe trade.

1664. SCHAFER, SCHERER, & CO., 74 Milton Street, London, E.C.—Patent Waterproofed Leather, such as Morocco, roan, hides, embossed leathers, &c.

1665. WARWICK, WALTER, 52 Haworth Street, Bolton, Lancashire.—Improvements in Machinery employed in the manufacture of leather.

1666. WILSON, EDWARD, Engineer, Exeter.—(1) Patent Disintegrator. (2) Patent Pinning or Striking Machine. (3) Butt Roller.

1667. DUFRESNE & LUDERS, 32 Cornhill, London, E.C.—Tanning Leather by electricity.

1668. RANDALL, L. D., & CO., Standard Works, Wapping, London, E.—(1) Horse Clothing, Oil Press Bagging, Railway Carriage Seatings, Cast Cloths, Leggings, Gaiters, &c., made from goat hair yarn. (2) Impermeable Fluid, for rendering flax, jute, and hemp yarns and cloth water-repellant and capable of resisting the changes of temperature. Specially adapted for cart and railway truck covers.

1669. NORRIS, S. E., & CO., 56-58 High Street, and St. Paul's Works, Shadwell, London, E.—(1) Photographs of Machines for preparing and currying leather, and for manufacturing leather millbands. (2) Specimens of such manufactures, including patent wood-link belting, &c.

1670. CARPENTER BROTHERS, 44 Wellington Street, New Kent Road, London, S.E.—Patent Leather Cutting Machine, with samples of work. This machine is an improvement upon the old gauge-cutting, and is worked by hand.

1671. GUEST, WILLIAM, 21 Clifton Road, New Cross, London, S.E.—(1) Improvements in the treatment of leather. (2) Special Stoves used in drying, &c.

1672. DERMATINE SYNDICATE, 7 William Street, Neate Street, Camberwell, London, S.E.—(1) Dermatine, a substitute for leather, &c. (2) Substitutes for india-rubber and gutta-percha materials.

1673. JEFFREY & CO., 64 Essex Road, Islington, London, N.—(1) Specimens of Embossed Leather, gilded and hand-painted, for hangings and mural decoration. (2) Specimens of Jeffrey & Co.'s Embossed Leather Papers, gilded and hand-painted. Many of these are reproductions of rare old Venetian and Spanish leathers.

CAVE, H. J., & SONS, 40 Wigmore Street, London, W. (See Group XXII.)

COBBETT, W. W., 82 Southwark Street, London, S.E. (See Group IV.)

MERRYWEATHER & SONS, Greenwich Road, S.E.; and 63 Long Acre, London, W.C. (See Group XI, Queen's Gate Annex.)

Anderson, Anderson, & Anderson,

(LATE ANDERSON, ABBOTT, AND ANDERSON,)

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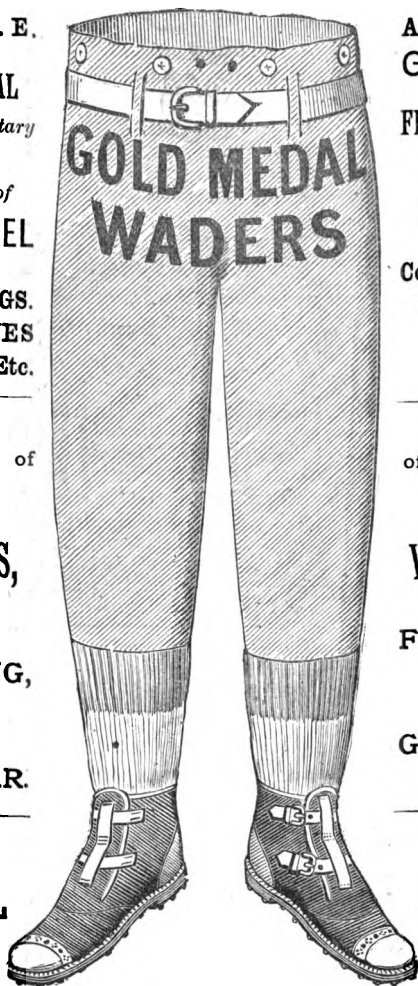
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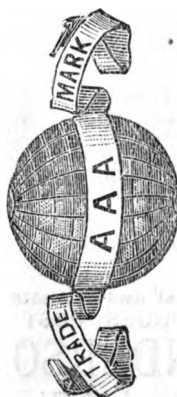
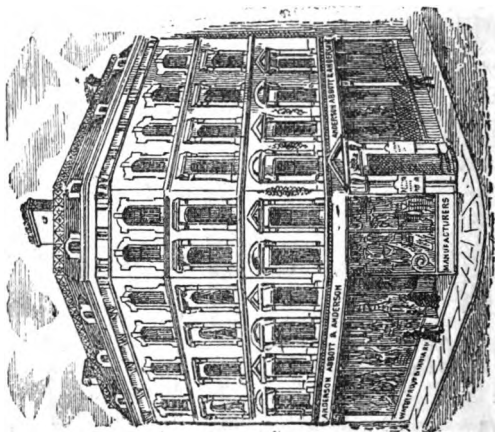
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Gold Medal, Amsterdam, 1869.

Gold Medal, South Africa, 1877.

Gold Medal, Paris, 1878.



Silver Medal, Melbourne, 1881.

2 Gold Medals, Fisheries Exhibition, 1882.

Gold Medal, Calcutta, 1883-4.

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INDIA-RUBBER AND GUTTA-PERCHA, &c.

BY H. Y. DENT, F.C.S., F.I.C.

CAOUTCHOUC, or india-rubber, by which latter name this material is generally known in commerce, is the inspissated juice of a variety of plants growing for the most part in countries which possess a more or less tropical climate, having a mean temperature of about 80° F. It is obtained from North and South America, Asia, and Africa, the finest quality being that imported from Brazil and known as Para rubber. This description of rubber is the product of several species of *Hevea* which abound in the dense forests growing on the banks of the Amazon and its tributaries. The most important of these is the *Hevea Brasiliensis*, which attains a height of from 50 to 70 feet, the trunk being often as much as 3 feet in diameter. It flourishes best on a rich alluvial soil that is periodically inundated, but so drained as not to allow the water to remain stagnant.

The milky juice is collected at the beginning of the dry season by making incisions with an axe in the trunks of the trees, from which the milky sap flows continuously for from two to three hours into small clay basins prepared to receive it. The juice rapidly coagulates on exposure to the air, and is then dried by being held over a wood fire, the smoke of which blackens the rubber. When a sufficient thickness of rubber has accumulated upon the wooden bat used for holding the rubber over the fire, it is cut open and the rubber is obtained in the condition in which it is exported to Europe. The rounded balls of rubber known by the name of negrohead is only another form of Para rubber, but of inferior quality, on account of its containing fragments of wood and other impurities frequently to the extent of 25 per cent., which have to be subsequently removed by washing.

The number and variety of rubber-yielding plants is very considerable.

The Ceara rubber from Central America, obtained from Brazil, but from a different plant to that which yields the Para rubber, is perhaps next to it in quality. It is the produce of the *Manihot Gladiolifolia*, which will grow on a poorer soil and in a drier climate than the *Heveas*, attaining the height of 30 feet, and after a growth of two years has a stem 4 or 5 inches in diameter. This tree is one of those which have been successfully cultivated in Ceylon. In some parts of Central America, such as Mexico, Honduras, Panama, &c., rubber is obtained from a large tree (*Castilloa Elastica*), the trunk of which is sometimes as much as 8 feet in diameter, and to obtain the rubber it is customary in Panama to fell the tree, which will often yield as much as 100 lbs. of rubber.

The rubber from Assam, Java, and Rangoon is chiefly obtained from the *Ficus Elastica*, a large tree which in Assam attains the height of 100 feet. The juice obtained from this tree contains less rubber than that from the American tree, frequently not more than 10 per cent. instead of from 20 to 35 per cent. The reckless and wasteful manner in which the juice was at one time collected by the natives threatened the destruction of the trees producing it; but better regulations have since been made, and the trees are now cultivated in regular plantations, the result being that the Assam rubber is acquiring much greater commercial importance than was the case a few years ago.

In Borneo, Singapore, Sumatra, Penang and other islands of the Malayan Archipelago, rubber is obtained from a climbing plant having a very thick stem (*Urceola Elastica*), which can be tapped after three years' growth. The rubber is of a somewhat hard and fibrous character, but of good quality, and well adapted for the manufacture of ebonite and other purposes.

The Mozambique and Madagascar rubbers are also obtained from a climbing shrub, of which there are several varieties yielding different qualities of rubber; but as no care is taken by the natives to separate the different qualities, the rubber as imported does not command a high price. Plants yielding rubber extend all across Tropical Africa, of which the *Landolphia Kirkii* (named after Dr. Kirk, who introduced the seed into India) is the most valuable. From

every part of the stem of these climbing plants exudes, when cut, a milky fluid which dries very quickly, and is collected by the natives, who cover their arms with it until a mass of some considerable thickness has been accumulated, which, when sufficiently dry, is peeled off.

The quality of rubber is estimated commercially by its elasticity, odour, and freedom from mechanical impurities, the various descriptions of rubber being generally distinguished by the name of the place from which they are severally obtained. Within the last few years considerable attention has been paid to the cultivation and acclimatization of the more valuable rubber-producing trees, and in 1876 and 1877 measures were taken at Kew for raising seedlings of the South American plants, 2000 of which were sent out to Ceylon, where the plants are now being cultivated with some prospect of success. Caoutchouc has been known since the discovery of America by Columbus, whose notice it did not escape. It is alluded to by Juan de Torquemada who, 250 years ago, speaks of it as being used for shoes and for waterproofing the clothing of the Spanish soldiers. The first account of this substance that can be regarded as in any way scientific is to be found in the 'Transactions of the Academy of Sciences' for the year 1736, as given by M. de la Condamine, who was despatched by the French Government on a scientific mission to South America, where he found caoutchouc in use by the natives for boots, bottles, and syringes, but it does not however appear to have been applied to any practical purpose in Europe until nearly the close of the 18th century, when a patent was taken out in the year 1791 for its application to waterproofing purposes. The solvent first employed was oil of turpentine, but in 1823 coal-tar naphtha was proposed by Macintosh, and has been more generally used up to the present time for dissolving caoutchouc.

Improvements in the mode of working and using the material rapidly followed each other. In 1820, Hancock invented a machine for working up the rubber as imported into a uniform and homogeneous mass, termed a masticator, a modification of which is still used for the same purpose, and by means of which the rubber is rendered more permeable to liquids and reduced to a condition in which it is more readily acted upon by solvents or other chemical reagents.

Caoutchouc is altered in its character by being subjected to changes of temperature becoming hard and rigid at 32° F., and quite soft at a temperature of 212° F. It is also liable to deterioration by exposure to light and air, a thin film of caoutchouc being soon converted into a brittle resinous substance when exposed for any length of time to atmospheric influences.

In 1843, the important discovery was made by Charles Goodyear in the United States, and Thomas Hancock in England, that by mixing the caoutchouc with sulphur and subjecting the mixture to a temperature a little above that of the melting-point of sulphur, the character of the rubber was changed, and that after undergoing this treatment the rubber, whilst retaining its elasticity, was not acted upon by the usual solvents, and was no longer affected by change of temperature as is the case with the pure caoutchouc.

This process, to which the name of vulcanizing has been given, is carried out in various ways. The proportion of sulphur used, the temperature to which the mixture of caoutchouc and sulphur is subjected, and the time during which it is exposed to this temperature, varies according to the quality of the rubber, the thickness of the sheet to be vulcanized, and the nature of the product desired to be obtained.

The proportion of sulphur usually employed in making vulcanized sheet may be taken from one-sixteenth to one-tenth the weight of the rubber. If the proportion of sulphur is increased to about one-third the weight of the rubber, the temperature raised to 300° F., and the time be increased to from 12 to 24 hours, or even longer, as is frequently the case, the rubber becomes converted into the hard brittle substance known as ebonite or vulcanite.

When a mixture of caoutchouc and sulphur is exposed to the sun's rays, the caoutchouc becomes slowly vulcanized to some extent, of which property advantage is taken in the manufacture of hats and helmets, made of segments of cork cemented together with a solution of rubber to which a little sulphur has been added, this small amount of sulphur causing the cement to increase in hardness and toughness, which would not be the case if the sulphur had been omitted. It is to this continued action of sulphur upon caoutchouc by exposure to light that rubber goods so frequently become hard and brittle, which is more especially the case when any excess of sulphur beyond that actually required for vulcanizing has been employed.

Rubber is also vulcanized by metallic sulphides containing a slight excess of sulphur, the

sulphides of lead, antimony, and zinc being those most generally employed. The red vulcanized rubber, which, when properly manufactured, retains its elasticity for a very long time, is prepared by means of antimony sulphide, and its durability is probably due to the fact that rubber, when cured in this manner, is less liable to contain an excess of free sulphur. The mixture of caoutchouc and sulphur is spread over the fabric to be waterproofed, which is then subjected, for from two to three hours, to a temperature of from 240° to 280° F.

The high temperature to which it is necessary to subject the goods to be cured in order to ensure perfect vulcanization of the rubber prevents this process being adopted when the fabrics to be waterproofed consist of silk or wool, since they could not be subjected to such a temperature without being injuriously affected. The light waterproof cloaks and coats now so generally worn are not therefore "steam vulcanized," as it is termed, but are subjected to what is known as the cold curing process, which was first proposed by Parkes in 1843. The vulcanization of the rubber may be effected by either dry or moist heat.

Surface vulcanization of the rubber is effected without the assistance of heat by exposing the rubber to the action of the vapour of chloride of sulphur, or to a solution of chloride of sulphur in carbon disulphide. In waterproofing fine double texture cloths of silk and wool a process is adopted which was first proposed ten years ago, which consists in covering one of the surfaces of each piece of fabric to be united with a solution of rubber, and passing the covered surfaces of the fabrics over a roller mounted in a vessel containing a mixture of chloride of sulphur and carbon disulphide. The coated fabrics are then passed between a pair of nipping rollers, which causes the two rubber-covered surfaces to adhere together. A vulcanized double texture fabric is thus obtained without employing heat and without injury to the fabric. The description of grey vulcanized rubber, known as "A" quality, leaves after ignition only a small amount of residue, but the lower qualities generally contain varying proportions of zinc oxide, French chalk, whiting and other mineral matters, which decreases the elasticity of the rubber, and are added for the most part with the object of increasing the weight and lowering the cost.

Mineral matter is however sometimes added for the purpose of hardening the material and rendering it better adapted for special purposes. The rubber used in dentistry, which realises a very high price, is mixed with a variety of pigments for the purpose of imitating the colour of the gums and giving to the mixture the necessary solidity.

The manufacture of artificial ivory is another case in which pigments are used with considerable success, although the product hitherto obtained does not possess the elasticity and solidity of real ivory.

Various substitutes for rubber have at different times been proposed which, although they cannot be considered as in any way comparable to rubber, are nevertheless capable of being used for many purposes. The basis of most of these is linseed oil, which has been boiled down to a thick fluid; to this is added rosin, shellac, pitch, fibrous matter, powdered wood, &c., thus forming a mass that is capable of being converted into boxes, match cases and various ornamental articles. Linseed and other drying oils treated with sulphur, or treated with chloride of sulphur under the name of "vulcanized" oil, are also much employed for the purpose of imitating rubber.

Many attempts have been made to utilize waste vulcanized rubber by working it up with caoutchouc, and by other methods which have formed the subject of numerous patents, but the product obtained is of very inferior quality, and can only be worked up into low class goods. Vulcanized rubber is largely used for insulating purposes, as well as for valves, tubes, springs, washers, &c., and in the form of ebonite for insulators, acid pumps, battery cells, and vessels for holding corrosive liquids.

The compositions of which rubber forms a part are very numerous. It is used in the manufacture of kamptulicon and other coverings for floors, artificial whalebone, artificial leather, varnishes and lacquers, combs, knife handles, as well as many others.

GUTTA-FERROHA, which, as regards many of its properties, is not unlike caoutchouc, is obtained from the juices of trees, of which there are several varieties belonging to the natural order, *Euphorbiaceae*, growing for the most part in Singapore, Borneo, and other islands of the Eastern Archipelago. The word gutta is of Malay origin, signifying gum, whilst percha represents the name of the tree which yields it. The juice is obtained by felling the tree and cutting rings in the bark, from which the sap flows. This is allowed to coagulate (to effect which it is sometimes

necessary to apply artificial heat), and is then kneaded into the rounded masses in which it is imported into Europe.

Gutta-percha has long been known as an article of curiosity, but received no practical application in Europe prior to the year 1843, when it was introduced into England by William Montgomery, who had been for some years assistant-surgeon to the Residency at Singapore, and who successfully exerted himself in drawing attention to the valuable properties possessed by this substance, rendering it readily adaptable to a great variety of purposes. The crude gutta-percha is cleansed from the extraneous matter it contains by being passed through machinery which tears it to pieces; it is then drawn into a tank of water heated by steam, in which the heavier impurities are separated by subsidence. The gutta is collected together and transferred to a masticator or kneader heated by steam, against the sides of which it is forcibly squeezed by a revolving cylinder which expels the air, the gutta being worked up into a perfectly homogeneous mass. For special purposes the gutta is further purified by being forced in a melted condition through strainers, by which treatment fragments of bark and other light substances are eliminated, and after being again passed through the masticator the gutta is in the highest condition of commercial purity.

The purified gutta-percha is usually kept in sheets varying in thickness, and to obtain it in this form the gutta-percha as received from the masticator, and still in a warm plastic condition, is passed through rollers adjusted to the nature of the sheet required; these rollers are capable of being drawn together sufficiently close to produce the thin tissue which is now so much used instead of oiled silk.

If exposed for any length of time to atmospheric influences it becomes friable and brittle from the effects of oxidation, and it is therefore advisable that articles made of this material should be kept in water, or in a dark cool place.

Gutta-percha is largely used for insulating purposes; its great plasticity renders it admirably adapted for taking impressions, and for the manufacture of tubes, bottles, and other articles whilst its indifference to acids makes it invaluable for many chemical purposes; bottles of this material are employed for holding hydrofluoric acid, a substance which corrodes glass very rapidly. Gutta-percha is sometimes mixed with lime, clay, magnesia, and other mineral matters with which it is capable of being combined to the extent of 25 per cent. without losing its plastic properties, such mixtures being used for handles, picture frames, and other purposes for which the pure gutta-percha would be too soft; it is also mixed with colouring pigments for ornamental purposes, and with tar and rosin for cementing gutta-percha to wood. Gutta-percha is altered in its character by being subjected to the action of chloride of sulphur, and is less easily softened by heat after this treatment.

There is considerable difference in the quality and value of commercial gutta-percha, the lower qualities being obtained from plants which yield an inferior description of juice. Balata, obtained from the "bullet tree" of British Guiana, was at one time used to a considerable extent for mixing with gutta-percha, but very little is now imported.

GROUP XXI.—INDIA-RUBBER AND GUTTA-PERCHA, &c.

EAST QUADRANT AND EAST GALLERY ANNEXE.

[For use of Gutta-percha, &c., in *Electrical Insulation*, see Group XIII.; for *Artificial Leather*, see Group XX.; for *Kamptulicon*, see also Group XXII.]

1681. **INDIA-RUBBER, GUTTA-PERCHA & TELEGRAPH WORKS CO., Limited**, Silvertown, London, E.—India-rubber and Gutta-percha Raw Material and Manufactured Articles.

1682. **HEMBRY & CO., 16 Newgate Street, London, E.C.**—Linoleum, with paper foundation for damp walls, made with borders on one side for dados or without, for covering entire wall or ceiling.

1683. **MOSES & MITCHELL, 68-72 Chiswell Street, London, E.C.**—Vulcanized Fibre, hard and flexible. Hard is a substitute for metals, vulcanite, ebonite, ivory, &c. Flexible, for rubber, leather, percha, &c.

1684. **CORDING, J. C., & CO., 19 Piccadilly, London, W.**—Native Rubber in raw state as collected, and also in various stages after cleansing, masticating, &c.

1685. **MATLAND, G. R. & T. C., 180 & 182 Commercial Road, London, E.**—Improved process of manufacturing dentures &c., from vulcanite and celluloid.

1686. **WATSON, EDWARD, 34 South Back, Canongate, Edinburgh.**—Substitutes and application of india-rubber, vulcanized and unvulcanized.

1687. **CORDING, GEORGE**, 125 Regent Street, London, W. — (1) Patent Rubber-proofed Cloths and Patent Mats and Sponge Rubber. (2) Patent India-rubber Collar Studs, Moulds, and Dies for Manufactures.

1688. **WARNE, W., & CO.**, 29 Gresham Street, London, E.C. — Specimens illustrating the application of India-rubber to various uses.

1689. **GAUSSEN, D.** (Agents, J. C. CORDING & CO., 19 Piccadilly, London, W.) — The V. W. H. Patented Hollow Corrugated Vulcanized India-rubber applied for various purposes.

1690. **BRITISH XYLONITE CO.**, Limited (THE), 124 High Street, Homerton, London, E. — Xylonite and Celluloid in sheets, rods, and tubes, for combs, piano keys, knife handles, surgical instruments, and electric Batteries.

1691. **HUTH, A. H.**, Bolney House, Ennismore Gardens, London, S.W. — Improvements in the manufacture of india-rubber, gutta-percha, and the allied products.

ASBESTOS CO., Limited (THE UNITED), 161 Queen Victoria Street, London, E.C. (*See Group IV.*)

MENNETT, J. T. B., 60 Anglesey Street, Lozells, Birmingham. (*See Group XIV.*)

BIRD, F., & CO., 11 Great Castle Street, Regent Street, London, W. (*See Group VI.*)

BODY, WILLIAM, Wittersham, Ashford, Kent. (*See Group VI.*)

CALENDER'S BITUMEN TELEGRAPH AND WATERPROOF CO., Limited, 101 Leadenhall Street, London, E.C. (*See Group XIII.*)

COBBETT, W. W., 82 Southwark Street, London, S.W. (*See Group IV.*)

COPPARD, J., & CO., 35 Holloway Road, Islington, London, N. (*See Group XVII.*)

HARTLEY, REGINALD, Carshalton, Surrey. (*See Group VI.*)

HUTH, A. H., Bolney House, Ennismore Gardens, London, S.W. (*See Group XIII.*)

PEAT, HENRY, & CO., 173 Piccadilly, London, W. (*See Group VI.*)

RANDALL, H. E., Ladies Lane; and Wood Street, Northampton. (*See Group XVIII.*)

STEWART, JAMES HENRY, 406 Strand, London, W.C. (*See Group XXVIII.*)

WINTER, S., 9 & 11 Sussex Place, Queen's Gate, South Kensington, London, S.W. (*See Group XVIII.*)

ZINGLER, M., 19 Buckland Crescent, Belsize Park, London, N.W. (*See Group XX.*)

Manufacturers to the



War Department.

WM. WARNE & CO.,**India Rubber Manufacturers,**

Patentees of the

MAGNETIC-CUT INDIA RUBBER THREAD,**Red Mineralized India Rubber,***For Valves, Washers, and Hose, for Tropical Climates, &c.***New Moulded Seamless Hose,**

THE NEW MOULDED ENEMAS,

CATHETERS AND BOUGIES.

THE MARVELLOUS TOOTH BRUSH,



TRADE



MARK.



The "Hand Emollient" and "Sultan's" Bath Brush.

The "Prince of Wales," "Omnium Gatherum," "Mineralized Corrugated," "Sultan," "Premier," and "Gordon" Tobacco Pouches.

Royal Aromatic Elastic & Imperial Bands.

MANUFACTURERS OF

EVERY DESCRIPTION OF INDIA RUBBER

Sheets, Valves, Washers, Buffers, Cord, India Rubber & Canvas Packing,

Delivery & Suction Hose Pipes for Fire Engines, Steam Packets, &c.

Gas Tubing, Lawn Tennis Balls, Enemas, Syringes, Catheters, Water Beds, &c.

THE ARMY AND NAVY REGULATION COATS AND CLOAKS.

Piece Goods, Cart and Wagon Covers, Air-Proof Beds, Cushions, &c. Solid India Rubber Mats and Matting.

.....

29, GRESHAM STREET, E.C.

MILLS:

**Tottenham, LONDON.**

GROUP XXII.—FURNITURE AND ACCESSORIES—FANCY GOODS.

SOUTH CENTRAL GALLERY.

for Bronzes and Alloys, see Group II.; for Household Pictures, see also Group III.; for Manufacture of Carpets, see Group IX.; for Rug and Mat-making, see also Group IX.; for Glass and China, see Group XXIII.; for Paper Hangings, see Group XXVI.]

1698. SANDERSON, A., & SONS, 52 Berners Street, London, W.—(1) The Mosaic Wall Decoration. (2) The Patent Mosaic Paper, which is washable, hygienic and waterproof.

1699. HARRIS, J. F. & G., 58 Wilson Street, Finsbury, E.C.; and Orange Street, Gravel Lane, Southwark, London, S.E.—Mouldings and Fancy Wood Decorations.

1700. BETJEMANN, G., & SONS, 36 38 & 40 Pentonville Road, London, N.—(1) Expanding Dressing Cases. (2) Triple Opening Travelling Bag. (3) Quadrant Opening Bag. (4) Euliyarde Cigar Box Lock. (5) Perfume and Spirit Stands. (6) Double Opening Glass Ink Bottle Cap. (7) Musical Table Bell. (8) Spring Back Desk. (9) Improved Patent Bookslide.

1701. LEE, R. J., 6 Savile Row, London, W.—Patent Table Chair, the Duplex.

1702. DALTON TIME-LOCK SYNCATE, Limited (THE), 69 Coleman Street, London, E.C.—(1) The Dalton System of Burglar-proof Safes and Safe Bolt Work. (2) The Dalton System of Fireproof Safes, Safe Deposit Vaults, Iron and Steel Doors. (3) The Dalton Permutation Lock. (4) The Dalton Time Lock and Double Guard Lock. (5) The Dalton Unlocker.

1703. PRATT, C., & SONS, North Parade, Bradford.—(1) Furniture and Upholstery. (2) Floor Coverings and Wall Coverings.

1704. WALLACE, W., & CO., 151, 153 Curtain Road, London, E.C.—Combination Bedroom Suite and Patent Furniture.

1705. COKE, ARTHUR, 339 Oxford Street, London, W.—(1) Patent Self-drying Umbrella. (2) Improved Manufacture of Spitalfields Silk. [Hand loom in operation.]

1706. CAMERON, AMBERG, & CO., 17 Little Britain, London, E.C.—Amberg's Patent System of Letter Filing.

1708. WILKINSON, T., & SONS, Pelican Works, Great Hampton Street, Birmingham.—Patent Pelican Ware, or Unfurnishable Electro-Plate, decorated in colours.

1709. WALLACE, MRS. WILLOUGHBY, 3 Eastern Villas, Southsea.—A Revolving Tidy Table.

1710. ALLEN, JAMES, Queen's Hotel, Leeds.—Chair of Improved Construction for hotels, clubs, and general purposes, with immovable joints, without braces.

1711. PAICE, ALEXANDER, 46 Union Street, Ryde, Isle of Wight.—A Double-action and Expanding Writing Cabinet. Especially designed for the boudoir, yachts, ships, &c., where room is an object.

1712. FITTON, EDWARD B., Fair Lea, Great Malvern.—Pivot Seats for all positions, specially designed for use behind shop counters.

1713. FOLEY, ARTHUR, Fisherton Steam Cabinet Works, Salisbury.—(1) Patent Economic Combination of Chimney Piece and Coal Receptacle. (2) Patent Combined Fender and Coal Vases, to fit any size hearth.

1714. BEAUMONT, E. C., & CO., 43 Imperial Buildings, Ludgate Circus, London, E.C.—Table Punkah.

1715. FEAR, E. J. C., Hampton Park, Redland, near Bristol.—Zephyrifer or Air Bringer. Consisting of an automatic fan or punkah, operated by mechanical or electrical means.

1716. LAMMERS, C. L. H., 2 Roseworth Terrace, Gosforth, Newcastle-on-Tyne.—Improvements in panels, plates, and name plates of all kinds of metal or compound metals, and the method of producing and filling up letters, figures, and designs in such plates.

1717. GAINSFORD & CO., 163 to 167 Borough, London, S.E.—Improved Writing Table.

1719. SIMPSON, W. B., & SONS, 100 St. Martin's Lane, London, W.C.—Anglo-Limoges Enamels, with patented system of sectional jointing as in stained glass.

1720. JEFFRIES, A., & CO., 107 New Oxford Street, London, W.C.; and Grove Works, Clapham Junction.—Improvement in the manufacture of white mouldings, gold picture frames, and artists' materials.

1721. LYLE, JAMES, 57 Bishopsgate Street Within, London, E.C.—Patent Portable Folding Furniture, Tables and Rout Seats.

1722. HAMPTON & SONS, Pall Mall East, Charing Cross, London, S.W.—Combined Library Steps and Easel.

1723. HALL, JOSEPH, Wharncliffe Chambers, Bank Street, Sheffield.—(1) Autopert Biscuit Box [self-opening]. (2) Spirit Canteen [combined lock-up liquor frame and receptacle for cigars, &c.] (3) Dram Flask

[cup and flask combined]. (4) Non-conductor for tea-pots, &c. (5) Egg-cutter, or apparatus for opening eggs.

1724. GROTH, L. A., 30 Finsbury Pavement, London, E.C.—Producing Architectural Ornaments from wood or other fibrous pulp.

1725. WALSH & BRIERLEY, 58 & 59 Aldermanbury, London, E.C.; & 26 Oldham Street, Manchester.—Improvements in umbrellas, consisting of the using of tubular ribs into which the seams are inserted [See's Patent].

1726. BROWN, WILLIAM & FRANK, & CO., Eastgate Row, Chester.—Patent Wood Mosaic, formed of small blocks of woods end-grain upwards for ornamental interior work.

1727. FORRESTER, H., 5 Margaret Street, Hanley, Stoke-on-Trent.—New Method of Inlaying Wood.

1728. NEW PATENTS DEVELOPMENT ASSOCIATION, Limited (THE), 49 Glengall Road, Old Kent Road, Surrey.—(1) Improvements in the production of designs on wood in imitation of carved work. (2) An Improved Process of cleaning imitation carving on wood. (3) Improvements in producing designs or figures on or in wood in imitation of carved work. (4) Improvements in and apparatus to be employed for the process of producing designs or figures on or in wood in imitation of carved work. (5) An Improved Machine for carving, milling, drilling, cleaning, and other similar operations.

1729. DAVIS, HENRY ALBERT, 13 Poultry, Cheapside, London, E.C.—The Patent Compactum Umbrella.

1731. ORMEROD, EDWARD, West Drayton, Uxbridge.—Improved Painting and other Brushes.

1732. HINDE BROTHERS, 1a City Road, London, E.C.; and 108 Suffolk Street, Birmingham.—Improvement in brushes.

1733. HORSEY'S PATENT BROOM & BRUSH MANUFACTURING CO., Limited (JOHN G. HORSEY, Managing Director), 37 Queen Victoria Street, London, E.C.—Patent Machine-made Steel-fastened Brooms and Brushes, each tuft being separately secured with steel fastener in a solid stock.

1734. MASTERS, JOHN, 175 Goswell Road, London, E.C.—Improvement in brushes for technical and manufacturing purposes.

1735. PIERREPONT, DR. EVELYN, 22 Old Burlington Street, Bond Street, London, W.—Patent Thorough Cleansing Teeth Brushes, adapted to the shape of the mouth.

1736. MILBOURNE & HUMPHREYS, The Willow Warehouse, Bridgewater Viaduct, Knott Mill, Manchester.—(1) The Manchester Skip, with improved fastener, undetachable clogs, unbendable ends, sides, and lid. No nails, screws, or bolts. (2) Mill Doffing Skip, as described above. (3) Warehouse Wagon Skip.

1737. COLLEAN, JOSEPH ALFRED, Sea View, Swanage, Dorset.—Plaiting, Weaving, Printing, and Perforations in Straw.

1738. LOEWENSTARK, A. D., & SONS, 210 Strand, London, W.C.—New Regulation Military Buckles, exhibited with war medals attached.

1739. AARON, SONS, & CO., 18 Jewin Street, Fore Street, London, E.C.; and 1 Coppinger's Row, Dublin.—(1) Patent One-Hand Self-opening Umbrella, suitable for parasols and sunshades. (2) Mohair Cloth Umbrella.

1740. THOMASSON, T., & CO., Silver Street, Worcester.—Improvements in fastenings for travelling and other trunks, illustrated by a selection of models and full-sized finished articles.

1741. LLOYD, SAMUEL, & CO., Drayton Works, Sidney Street, Wolverhampton.—(1) Patent British Travelling Trunks. (2) Patent Invulnerable Travelling Trunks. (3) Patent Invulnerable Deed Boxes. (4) Patent British Deed Boxes.

1742. CAVE, H. J., & SONS, 40 Wigmore Street, London, W.—(1) Portmanteaus. (2) Travelling Bags. (3) Dress Baskets. (4) Hampers for laundry use.

1743. DREW, J., & SON, 33 Piccadilly Circus, London, W.—Inventions in travelling equipment and dressing and travelling bags.

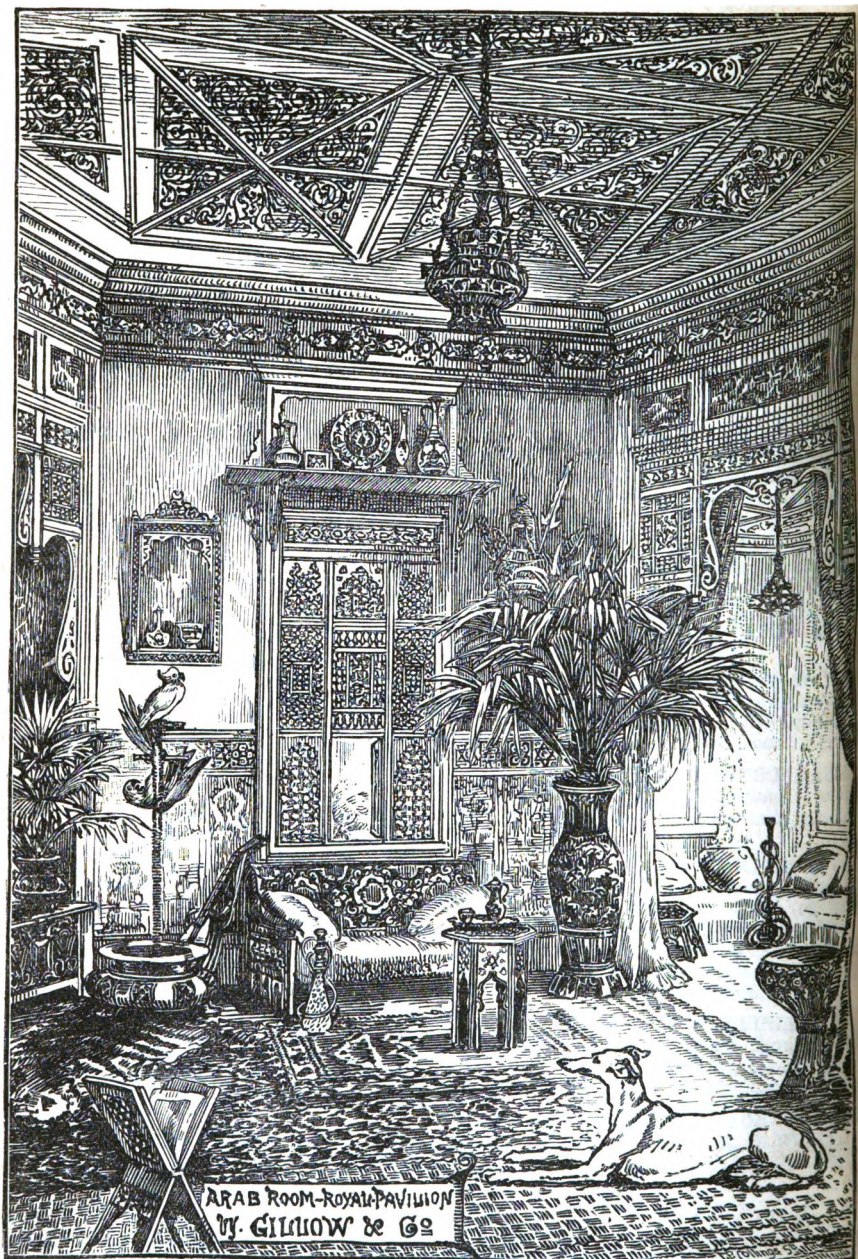
1744. SCOTT, G. W., & SONS, 43 Old Compton Street, Soho Square, London, W.—(1) Fitted Luncheon Baskets. (2) Railway Luncheon Baskets. (3) Buckets and Military Cooking Canteens. (4) Artistic Wicker Furniture. (5) Game Panniers for the moor. (6) Water Bottles, enamelled iron, felt covered.

1745. WICKER FURNITURE CO. (THE), 59 Wigmore Street, London, W.—(1) Despatch Basket-making Machine. (2) Improved Atmospheric Gas Apparatus.

1746. JACKSON, W., 106 Denbigh Street, Pimlico, London, S.W.—Camp and Barrack Furniture, and Patent Cork Cloth and Silk as a buoyant fabric.

1747. HENDRY, WHYTE, & STRACHAN, National Floorcloth and Linoleum Works, Kirkcaldy.—Linoleum.

1748. LINCRUSTA & GENERAL DECORATING CO., Limited (THE), 184 Oxford Street, London, W.—Combi-



ARAB ROOM-ROYAL PAVILION
BY GILLOW & CO

nation Mantel or Chimney Piece and Fire Screen.

749. STORY BROS. & CO., Lancaster.—A new Fabric for the decoration of walls in lieu of paper.

750. REES, W. A., 1 Fairbridge Villas, Fairbridge Road, Upper Holloway, London, N.—Improved Cornice Pole Rings, and Patented Cornice Poles.

751. EYLES, MRS. J. F., Clarence Villa, Powis Grove, Brighton.—A Pair of Wreaths, made from the bones, eyes, ears, &c., of fish, which have been formed to imitate flowers, leaves, &c.

GILLOW & CO., 408 Oxford Street, London; Branches: Lancaster, Liverpool, Manchester.—Decorators and Furnishers to Her Majesty the Queen and the Royal Family. (1) The Furniture and Appointments of the Vestibule in the Arab style. (2) A Drawing-room in the style of Louis XIV. (3) A Dining-room. The chairs and panels are of the 18th Century from the Royal Windsor Works. (4) A Dining-room. [The whole of the furniture arranged in the Royal Pavilion being supplied by Gillow & Co.] N.B.—As the Royal Pavilion must be removed at the close of the Exhibition, permission has been obtained to use the whole of the building and the whole of the contents.

MERRY, W. & T., Digbeth, Birmingham; and 14 to 16 Cow Cross Street, London, E.C. (See Group XI, Queen's Gate Annex.)

MALFOUR & CO., Lane End Works, Tipton and Tamworth. (See Group III.)

BEAUMONT, G. & CO., 13 Red Lion Square, London, W.C. (See Group XV.)

BROWNLEE & CO., City Saw Mills, Port Dundas, Glasgow. (See Group III.)

BARTER, JOHN, 66 Beaufort Street, Chelsea, London, S.W. (See Group III.)

CHATWOOD, SAMUEL, Bolton; and 76 Newgate Street, London, E.C. (See Group XI.)

MURPHY & SON'S LOCK & SAFE Works, Limited, 128 Queen Victoria Street, London, E.C. (See Group X.)

CRYSTALLINE GLASS CO., Limited (THE), 96a Clerkenwell Road, London, E.C. (See Group XXIII.)

DREGHORN, GEORGE, Albert Cottage, Glebe Street, Inverness. (See Group II.)

FARADAY & SON, 3 Berners Street, Bedford Street, London, W. (See Group XIII.)

GAUNTLETT, C. & CO., Union Works, Trowbridge, Wilts. (See Group IX.)

HANCOCK, HENRY, 25 Claylands Road, Clapham Road, London, S.W. (See Group XXIV.)

HAWKSLEY, THOMAS, 357 Oxford Street, London, W. (See Group XXIV.)

HEMERY & CO., 16 Newgate Street, London, E.C. (See Group XXI.)

KENNEDY, WILLIAM, 70 Robertson Street, Glasgow. (See Outside, South Promenade.)

KING, J. H., 64 Linthrop Road, Middlesbrough. (See Group XXIV.)

LANGTON, R. & SON, 9 King Edward Street, London, E.C. (See Group XVII.)

LYLE, JAMES, & CO., 57 Bishopsgate Street Within, London, E.C. (See Group XXVI.)

MERRYWEATHER & SONS, Greenwich Road, S.E.; and 63 Long Acre, London, W.C. (See Group XI, Queen's Gate Annex.)

MORTON, JOHN, 223 Oxford Street, London, W. (See Group XXIV.)

NEWTON, JOHN, 97 The Chase, Clapham, London, S.W. (See Group III.)

OSBORN & SHEARMAN, Paulton Works, 334 King's Road, Chelsea, London, S.W. (See Group XXVI.)

PARRY, JOHN, Eagle Foundry, Broad Street, Birmingham. (See Group XXIV.)

PARTRIDGE, JOHN, 29 City Road, London, E.C. (See Group XVI.)

PATENT LIQUID FIRE-PROOF CYANITE PAINT CO., Limited (THE), 82 Bishopsgate Within, E.C.; and Gunter Grove Works, Chelsea, London, S.W. (See Group XIV.)

PATENT MYCENIAN MARBLE CO., 6 Bunhill Row, London, E.C. (See Group III.)

ROWLATT, JOHN, 37 Wellington Street, Leicester. (See Group I.)

SIMPSON, W. B. & SONS, 100 St. Martin's Lane, London, W.C. (See Group III.)

STORMOUT, JAMES G., 112 Lionel Street, Birmingham. (See Group VI.)

VERITY BROS., 54, 56, & 58 Call Lane, Leeds. (See Group XXIX.)

WETHERED, LIEUT.-COL. E. R., 100 Herbert Road, Woolwich, Kent. (See Group XXIV.)

WOOD, J. P., 324 City Road, London, E.C. (See Group XVII.)

YATES, WILLIAM, Sherston, near Malmesbury, Wilts. (See Group XXIV.)

GROUP XXIII. POTTERY AND GLASS.

WEST QUADRANT.

[For Optical Glass, see Group XXVIII.; for Glass Apparatus, see Group XXVIII.]

1759. KNOWLES, HENRY, Albion Works, Woodville, Burton-on-Trent.—Improvements in Kilns.—(1) Models of Patent Continuous or Semi-continuous Direct Action Kilns. (2) Models of Patent Detached Draught Ovens and Kilns, with continuous direct action. (3) Model of Patent Fireplace for kilns, ovens, glass and other furnaces. (4) Model of Patent Binding for kilns, ovens, &c. (5) Model of Patent Perforated Bottom for kilns, ovens, &c. (6) Samples of Sanitary pipes, Fire Bricks, Tiles, Terra Cotta, &c., burnt in H. Knowles's patent kilns.

1760. CRAMP, J. P., Finedon Iron Works, near Wellingborough.—Kilns for drying and burning bricks and other articles.

1761. TUFFEE, W., 36 Parrock Street, Gravesend.—An Improved Coping Tile to prevent the percolation of damp down party walls above roofs.

1762. INDESTRUCTIBLE ENAMEL CO., Limited (THE), 35 Dudley Road, Wolverhampton.—Vitriifiable Lithographs and Photographs in enamelled iron.

1763. CANDY & CO., Limited, 11 Queen Victoria Street, London, E.C.—(1) Patent Vitreous Buff, Red and Glazed Terra Cotta. (2) Patent Terra Cotta and Stoneware Facing and Paving Bricks. (3) Patent Kiln for burning these bricks, and glazed stoneware, sanitary pipes and appliances.

1764. GAUSBY, J. B., 75 Wellington Road, Edgbaston, Birmingham.—Decorating walls, ceilings, &c., with enamel and other materials.

1765. BOWER, J. T., 56 Bayford Road, Sittingbourne.—(1) The Solid Corner Brick Moulds. (2) The Adjustable Bed Plate.

1766. DOULTON & CO., Lambeth, London, S.E.—(1) Fireproof Flooring, made of hollow blocks, thus combining lightness with strength. (2) Water Heater, by which a constant flow of water at boiling point may be obtained at a moment's notice.

1767. GILDEA, JAMES, Dale Hall, Burslem, Staffordshire; and 30 Holborn, London, E.C.—New process of painting on clay with coloured clay.

1768. WEBB, THOMAS, & SONS, Glass Works, Stourbridge.—(1) Various new methods and improvements in the manufacture and decoration of crystal and coloured glass. (2) The Newly Invented and Patented Self-acting Fountain, specially designed for the dinner-table, conservatory, or drawing-room window.

1769. FOSTER, B. E., 83 York Street, Westminster, London, S.W.—Krustallos, a new patent method of decorating glass and other surfaces, whereby all colours and designs are beautified, and effects produced having the character of silk, satin, plush, &c.

1770. WEBB, EDWARD, White House Glass Works, Wordsley, Stourbridge.—Improvements in the ornamentation of glass.

1771. BUDD, JAMES, 17 Heygate Street, London, S.E.; & 55 & 56 Chancery Lane, London, W.C.—(1) An improvement in the manufacture of ornamental glass. (2) An improvement in the constructions of ceilings. (3) An improved method or process of imparting to glass the appearance of marble or other stones. (4) An improved method of ornamenting or decorating glass in imitation of mosaic or similar work.

1772. SCHULTZ, J. C., 1 Laurence Pountney Hill, London, E.C.—(1) Improvements in Stopping Bottles. (2) Improved Bottle and Stopper for beer and aerated waters.

1773. HERMAN, W. D., Cropper's Hill, St. Helens, Lancashire.—Improvements in the combination of refuse materials of glass works with other substances for the purpose of making flags, bricks, tiles, and other like fictile or vitreous articles; also filter stones, grindstones, &c., which improvements are also applicable in the case of similar materials from other sources than glass works.

1774. LITTLE, C. P., 10 Fitzroy Street, Fitzroy Square, London, W.—(1) Latest methods of painting clay, faience and china adapted to tiles, vases, and architectural pottery. (2) Methods of using enamels on glass and painting it in grisaille. (3) Various kinds of Pottery and Glass Colours. (4) Metals used in decorating pottery and glass, including lustres. (5) Methods of painting linoleum and Japanese leather paper. (6) The new process of painting woollen fabrics with indelible dyes.

1775. ROSE, J., & CO., Coalport, Shropshire; & 35 Bloomsbury Street, Oxford Street, London, W.—New Designs in useful and ornamental china.

1776. GLENBORG UNION FIRE CLAY CO., Limited (THE), 4 West Regent Street, Glasgow.—(1) Dunnachie's Patent Continuous Regenerative Gas Kiln, for burning fire-bricks, sanitary ware, pottery, &c., without smoke. (2) Dunnachie's Patent Drying Stove. (3) Dunnachie's Star Heating Stove. (4) Improved Fire Clay and Silica Bricks.

1776. CRYSTALLINE GLASS CO., Limited (THE), 96a Clerkenwell Road, London, E.C.—Improvements in the treatment of vitreous and glazed surfaces for decorative purposes, whereby a permanent

crystalline or crystallized effect is produced, especially with reference to glass of all colours and tints used for window and other decoration, and for obscuring glass while in no way interfering with its light-transmitting properties.

1777. ORIGINAL CRYSTOLEUM CO. (THE), 200 Regent Street, London, W.—An improved and novel method of imitating ancient stained glass called Renaissance.

1778. SHARPE, M. T., 8 Campden Hill Road, Kensington, London, W.—Mirror Decoration. Likenesses and other decorative subjects are so painted on the glass that the glass itself protects them from injury.

1779. FLEXIBLE GLASS CO. (THE), 294 High Road, Kilburn, London, W.—Flexible Glass and Process of Manufacture.

1780. RANDS, G. L., 9 Apsley Road, Great Yarmouth.—Poison Bottle Safe-guard.

1781. RUST, J., 155 Buckingham Palace Road, London, S.W.—(1) Varied Antique Glass. (2) Improvements in the manufacture of vitreous slabs for painting upon or otherwise colouring. (3) Enamel and Vitreous Glass Mosaics.

1782. PELLATT, APSLEY, & CO., Falcon Glass Works, 17 St. Bride Street, Ludgate Circus, London, E.C.—(1) Etching upon glass. (2) Printing monograms, crests, arms and badges upon glass. (3) Cutting upon thin glass. (4) Club and Hotel Table Glass.

1783. MACKIE, W., Turk's Head Yard, Turnmill Street, London, E.C.—Patent Glass-blowing and Shaping Machines.

1784. TOUGHENED GLASS CO., Limited (THE), 75 Leadenhall Street, London, E.C.—Toughened Glass [Verre Trempe]: toughened crystal table glass, plain and decorated; toughened lamp glasses; toughened glass for chemical and laboratory use, &c.

1785. ART TILE CO. (THE), 92 Falcon Road, Battersea, London, S.W.—Glass Tiles for walls, hearths, floors, &c. [Bees' Patents].

1786. COOKE & TALLACK, 74 Namford Street, London, S.E.—Permanent Art Painting [by hand] on back of mirrors. This work is executed between the glass and silver.

1789. GRIFFIN, T. FEATHERSTONE, 7 Mandeville Place, Portman Square, London, W.—Hermetically-sealed Glass, China, and Earthenware Vessels.

BALFOUR & CO., Lane End Works, Loughton and Tamworth. (See Group III.)

BOLTON & PARTNERS, Limited, Malago Vale Works, Bristol; and 4 The Sanctuary, London, S.W. (See Group XIV.)

DALLIS, D. C., 12 Crane Court, Fleet Street, London, E.C. (See Group XXVI.)

FOULIS, JOHN, 28 Market Place, Musselburgh, Midlothian, N.B. (See Group XI.)

GARBETT, E. L., 3 Myddelton Square, London, E.C. (See Group IV.)

HONYWOOD, THOMAS, Courtenay House, The Causeway, Horsham. (See Group XXVI.)

JOHNSON, WILLIAM, Cardigan Works, Leeds. (See Group III.)

MINTON'S, Limited, Stoke-upon-Trent. (See Group X.)

MULLER, EMILIUS, 147 Gower Street, London, W.C. (See Group XXIV.)

ORMEROD, EDWARD, West Drayton, Uxbridge, London, W. (See Group III.)

PARRY, WILLIAM, 12 Lower Street, Caellippa, Bangor. (See Group III.)

PONTON, ARCHIBALD CAMPBELL, Viewfield, Parkstone, Dorsetshire. (See Group III.)

REDGRAVE, GILBERT R., Muswell Hill, London, N. (See Group III.)

SHARMAN, JOHN, 81 Liverpool Road, Islington, London, N. (See Group III.)

SIEMENS, F., 12 Queen Anne's Gate, Westminster, London, S.W. (See Group XVI.)

VINCENT, WILLIAM, Arborfield, near Reading, Berks. (See Group VI.)

WILSON, ROBERT, 68 Fleet Street, London, E.C. (See Group III.)

DENTISTRY.

Hempel's Newly-Invented Patent Removable Springs will be found most advantageous, and far more economical than those at present in use. They can be taken off, and be replaced by the wearer without the least trouble.

Mr. HEMPEL, Dental Surgeon, 379, Strand, W.C.

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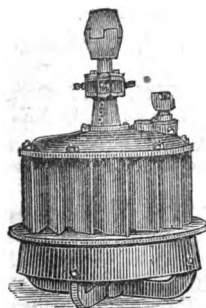
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1812. HAWKSLEY, THOMAS, 357 Oxford Street, London, W.—(1) Sets of Surgical Splints of different patterns of the V. W. H. patented corrugated vulcanized India-rubber. A pin leg cushioned with ditto, to counteract jar. Ambulance or Hospital Mattresses [single and double] of ditto. (2) Deafness: Otoacoustical Instruments to aid the ear. (a) Flexible Tubes conveying sound direct from speaker with bin-aural and other ear-pieces and special shaped collectors. (b & c) Portable Instruments of varying shapes and material, as horns, trumpets, resonators,

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1814. LOMBARDI, WILLIAM, 4 Argyll Place, Regent Street, London, W.—(1) Automatic Mallet for filling teeth. (2) Improved Forceps. (3) Appliances for regulating teeth.

1815. HEMPEL, A. C., 379 Strand, London, W.C.—Patented Improvements connected with removable springs for artificial teeth.

1816. JONES, DR. G. H., 57 Great Russell Street, Bloomsbury, London, W.C.—Improved Patent Dental Lathe and Electric Dynamo for illuminating the mouth.

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1818. JOHNSON, WILLIAM S., 103 to 107 Wellington Street, Glasgow.—Improvements in locks.

1819. PLUMPTON, GEORGE, Albion Tool and File Works, Warrington, Lancashire.—(1) Patent Gasfitters' Outfit or Combined Pliers and Screwing Tackle. (2) Improved Cutting Pliers for telegraph and wire-workers' purposes. (3) Improved Gasfitters' Pliers, &c.

1820. BAUER, J. C., 11 Comerford Road, Brockley, London, S.E.—(1) Patent Link Spanners. (2) Patent Screw Stocks and Dies. (3) Patent Self-gripping Tube Vices. (4) Patent Self-gripping Lathe Chucks.

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1822. KAYE, JOSEPH, & SONS, Patent Lock Works, South Accommodation Road, Leeds; and 93 High Holborn, London, W.C.—(1) Locks and Fastenings for both inside and outside railway carriage doors. (2) Locks and Fastenings of every kind for stations and offices. (3) Corrugated Oil Cans and Bottles, for locomotives, carriages and waggons. (4) New Patent Coupling. (5) New Patent Railway Wagon, Tip, and other Cart Door Holders. (6) Collector for excess fares and other tolls. (7) New Patent Railway Reservoir Penholders.

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1826. **PIKE, WILLIAM HENRY, Albion Hotel, Lanark, N.B.**—Alarms for door knobs, windows, till drawers, and cupboards, &c.

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1836. **DOUGLAS, C. D., & CO., 15 Queenhithe, Upper Thames Street, London, E.C.**—(1) Patent Springless Latch-Bolt Iron and Brass Mortice and Rim Locks. (2) Patent Springless Night Latches with small keys. (3) Patent Open Sesame Lock Furniture, no screws to work loose,—all working parts hidden. (4) Special Mortice Lock, large size; actuated by clockwork, exposing working parts, showing springless lock in action. (5) Patent Safety Automatic Springless Locks for railway carriage doors, which latch and lock the door in shutting, without force or noise. (6) Patent Springless Mortice Locks, actuated by pulling, pushing, or turning the handle either way.

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1853. **WILKINSON, G. W., 6 St. Mark's Terrace, Kensington, London, W.**—Atmospheric Gas Soldering Iron.

1854. **JONES, WILLIAM C., 26 Deodar Street, Chester.**—(1) Improved Castor for furniture. (2) Locks and Bolts.

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1857. **KING, J. H., 64 Linthorpe Road, Middlesbrough.**—Patent Double Acting

ever Lock and Key, specially adapted for
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1858. MARE, E. J. E., & JAMES
ALGAIRNS, 48 Batoum Gardens,
Kensington Park, London, W.—Self-
registering Tap for measuring liquids.

1859. GURNER, H. T., 24 Thaives
in, Holborn Circus, London, E.C.—
Patent Automatic Fastening for double doors
bookcases, wardrobes, &c.

1860. WOOD, C. S. P., Crown Works,
Birmingham.—Improvements in fastenings
safes or strong room doors, shown on Wood's
patent wedge, drill, and fire-resisting Victor

1861. TUCKER & REEVES, 55 Great
Russell Street, London, W.C.—Premier
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1862. MASEY, JAMES THOMAS,
West Ferry Road, Millwall, Lon-
don, E.—Protection of letters in pillar and
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1864. LEA, FREDERICK, 19 Buck-
ingham Street, Strand, London, W.C.—
patent Lever Sash Fastener.

1865. HANCOCK, HENRY, 25 Clay-
don Road, Clapham Road, London,
S.—The Paragon Automatic Bolt.

1866. PEIRCE, WILLIAM ADAMS,
Bank House, Woolstone, Hants.—
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1867. YATES, WILLIAM, Sherston,
Malmesbury, Wilts.—Upright Fur-
niture Castor, constructed in two parts, remov-
able for packing or other purposes.

1868. MORLEY, WILLIAM, 65
Elmer Road, Plumstead, London,
S.—Invention to prevent nuts and bolts from
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1869. GILL, W. A., 9 Arthur Street
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1870. WILKINSON, JOSEPH, The
Globe Castor Works, 26 Stanhope
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1872. TARLING, CHARLES, St.
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1877. MASON, ROBERT WILLIAM,
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1878. REES, HENRY, Bolingbroke
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1880. EMDIN, A., 8 & 9 Duke Street,
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1881. WETHERED, LIEUT. - COL.
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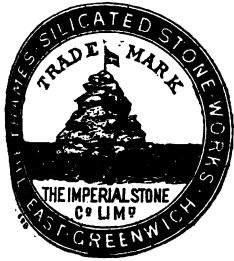
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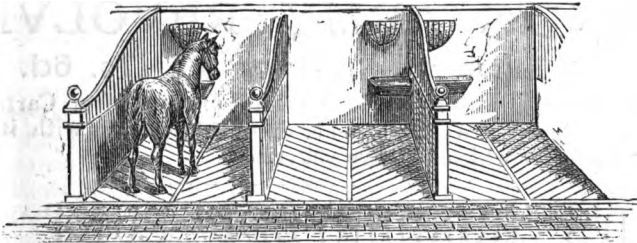
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By COL. SIR C. H. NUGENT, K.C.B.

During the last 25 years the advance in guns of all natures, but especially in heavy guns, has been very great. Rifling has been established, breech-loading has been introduced, and steel has taken the place of iron, while the proportions of guns have been materially altered with the effect of increasing their energy at least fourfold, and this with increase in length of range and still greater increase in accuracy.

At the commencement of this period the *built-up* guns of wrought iron and steel, which had displaced the cast metal smoothbore muzzle-loading guns of the preceding period, were rifled breech-loaders, but of small size.

But with the quick powders then in use, inconvenient pressures were developed in the guns as they grew in size, and Muzzle-Loading was again resorted to.

The first attempt to increase the power of these M. L. R. guns was by chambering, whereupon difficulties in loading from the muzzle at once manifested themselves; but when, as the next step, *downing* the powder and holding the projectile were looked to for a further increase of power, the advance to long guns was but a matter of time, and with them Breech-Loading became a necessity.

The rising calibres of guns leading to weights difficult to handle, gunmakers were induced to turn their attention to steel as the only material from which with less metal equal strength might be expected, and guns are now *built up* of this metal, but with the exception that forged steel hoops are substituted for wrought-iron coils.

Guns are also made upon the wire system, in which wire in tension is wound round the inner steel tube, and the coils of wire are covered by steel hooping.

In the earliest B. L. R. guns, which were small, the difficulties of rotation and the escape of powder gas were easily surmounted; with the heavier M. L. R. guns rotation was effected by rings of soft metal on the projectile which took the grooves of the rifling, while the gas was prevented from escaping by a *gas check*, a thin disc of flexible metal attached to the base of the projectile, which, when pressed by the gas, expanded and sealed the grooves.

With the longer B. L. R. guns the studs have been abandoned;—in the rifling many and shallow grooves have taken the place of few and deeper;—and instead of the gas-check two driving rings of soft metal are used, one near the base, the other behind the tapered head of the projectile.

Breech-closing.—Three systems of closing the breech are employed, named after their inventors, Armstrong, the Krupp, and the French.

In the two former Breech-blocks are made use of, moving into place through vertical or horizontal slots in the breech, and pressed home by screws.

In the French the breech is closed by a screw plug, which enters it from the rear. The ends of the plug and of the breech are divided into equal parts, of which the alternate parts are removed. When the threaded surface of the plug is opposite the plain surface of the breech the plug can be moved in and out easily, when the plug is in a turn causes the threads of both screws to engage, and the plug is firmly held. Sometimes a ring is introduced into a recess cut in the bore of the gun, sometimes an expandable metal cup or a pad of asbestos fixed on the inner end of the plug, to prevent the escape of powder gas.

Mounting.—The mounting consists of a carriage and platform; the carriage with its gun recoils along the platform upon discharge, returning to the position for firing partly by gravity, the slide or surface of the platform being inclined for the purpose; lateral motion is given to the carriage by the platform, which moves in a transverse direction upon racers set in the floor of the battery.

This lateral motion is called *traversing*, and for single guns is effected by hand power; where many guns are collected in one battery steam or hydraulic power is made use of.

In some M. L. R. guns the operations of loading, elevating, running in and out, and traversing are performed by hydraulic power.

The recoil of the guns after discharge is controlled by friction buffers, or by hydraulic buffers, of both of which there are numerous applications.

Mountings have been made in which the gun and carriage drop by recoil below the parapet and are then loaded under cover. In some of these they rise and fall by the action of counter-weights, in others by the agency of hydro-pneumatic machinery.

Muzzle pivoting.—These are forms of mounting in which the gun chamber, with its platform carriage and gun, are moved together by machinery. In one of these the muzzle of the gun pivots in the port hole of the armour by a ball and socket joint, and thus closes the entrance to the gun chamber.

Naval Guns.—No guns are made for naval use solely, though the first object of heavy guns is to meet naval requirements. The systems of mounting are in principle the same, but modified to meet the conditions which obtain on board ship. Speaking generally, the racers for traversing, already described, are replaced by slides, and blocks and tackles are more freely used.

Siege Guns.—Siege and field guns, though designed primarily for artillery purposes, find places in ship's armaments.

The first decided step was the M. L. R. gun introduced in 1872, and for a long time we rested satisfied with M. L. R. guns, but a better material for construction brought within reach higher velocities. B. L. R. guns are now made having as much velocity at 1000 yards as their predecessors had at the muzzle.

Mountain Guns.—For mountain warfare, guns are made in two or three parts, which can be carried separately, but are screwed together at the moment of entering into action.

The development of field-gun carriages has followed that of guns, the objects aimed at being lightness combined with strength and effective means for checking the recoil. Wood has given place in part to iron or steel, and the recoil is taken up by springs, by hydraulic buffers, or by twisted stay bars.

Projectiles.—Projectiles are common shell, Palliser shell, shrapnel, and case shot. They are made of iron for ordinary purposes, and of steel where great penetrative power is required, as in the attack of steel or compound armour, or where much interior space either for powder or for ball is required, as in the shrapnel of smaller siege and field guns.

Steel has not been successfully employed in the projectiles for the largest guns, and for the reliance is placed at present upon chilled projectiles, the heads of which are cast in iron moulds while the bodies are cast in sand; the windage allowed is so small that the surface of the projectile must needs be very true, and when the case admits the lathe is resorted to for accurate finish.

Machine Guns.—In machine guns the operations of loading, firing, and extracting the cartridge after firing, are performed by mechanism set in action by a simple movement and retained in action by the repetition of that movement.

The essentials of machine guns are rapidity of fire, lightness, and service by a minimum number of men.

Machine guns have one or more barrels, and are of various calibres, from that of small arms to that of field artillery; in the large calibres, however, the loading is performed in part by hand, and the number of barrels is ordinarily one; such guns are styled Quick-Firing guns.

Mitrailleuse.—The earliest form was the mitrailleuse, and the first use of it was in the Franco-German war of 1870. In this piece 25 to 37 barrels were arranged round a central axis and were discharged at once; it was a volley gun.

Gatling Gun.—To this succeeded the Gatling gun of 10 barrels, in which the cartridges are fired independently. This gun can be fired as slowly or as rapidly as may be desirable. In the latest form of it, with the assistance of an accelerating feed, upwards of 1000 rounds can be fired in a minute.

Then followed a great number of machine guns. In some the barrels, one or more, are disposed horizontally, side by side, ensuring a lateral distribution of fire; in others they are disposed round a central axis; distribution of fire is in some provided for by a pivot mounting combined with a shoulder piece, and a pistol trigger for firing.

Rapidity of fire appears to vary between 300 and 800 rounds per minute, depending

somewhat upon the number of barrels; but when accuracy is enforced the rapidity drops to about one half.

Notice of a machine gun has been issued recently, in which the recoil after discharge is utilized to assist in performing the operations of loading and firing.

Magazine Guns.—Magazine guns carry a supply of ammunition, usually under the barrel or in the stock, so arranged that the cartridges pass automatically into the barrel and are fired without recharging, until the magazine, containing from 6 to 12 rounds, is exhausted; the magazine adds to the weight, and interferes with the balance of the arm. Many of these guns may be used at pleasure as ordinary breech-loaders.

In the guns carrying the magazine under the barrel, the magazine is a brass tube charged through a hole in its side; the cartridges are thrust towards the breech by a spiral spring and raised by a hopper to the barrel.

Chronographs.—The instruments used in measuring velocities of projectiles are based upon the measurement of the interval of time during which the projectile is passing between two screens at a known distance apart; the general arrangement is that each screen is in electrical connection with the observer, the passage of the projectile through the screens severs the connections, and automatically records the severances; from the difference in time of the two severances and the distance between the screens the velocity is calculated; in some cases the severances of the connections permit gravity to act, the differences of the distances fallen is the measure of the velocity; in other cases the severance of the connection arrests a primary current by which a weight is held up, and induces a secondary current by means of which the weight as it falls records its progress downwards on a surface of prepared paper.

These instruments are called chronographs, and there are other forms, as in the optical chronographs, and in an instrument which is based upon the discharge of a Leyden Jar through a given circuit.

Chronoscopes.—For the measurement of minute portions of time during which the projectile moves to different positions in the bore of the gun a chronoscope is employed; plugs are moved inside the bore, and in electrical connection with the recording instrument, the passage of the projectile along the bore severs the connections, which severances are recorded automatically at the instrument. This machine indicates portions of time less than the millionth part of a second.

Pressure Gauges.—The pressures in the bore of the gun are ascertained by means of pressure gauges; the gauge consists of a metal plug, in which a hard metal piston bears upon a cylinder of pure copper; the plug is placed in the gun in the proper position, and when the charge is fired the pressure of the powder gas causes the piston to compress the copper cylinder, the extent of compression is the measure of the pressure in the gun. There are other forms in which the pressure of the powder gas on the plugs is registered mechanically, electrically, or by the frequency of vibrations of known rates.

Recoil.—There are various methods of measuring the velocity of recoil; in general the carriage records automatically the length of its recoil upon a plain surface, while at the same time and upon the same surface are recorded the vibrations of a tuning-fork of known pitch. In these instruments an arrangement of electric magnets takes the place of the tuning-fork.

Accelerographs.—Accelerographs are designed to deal with the combustion of powder and the pressures developed thereby, upon the principle of the simultaneous record of the travel of a body set in motion by the powder gas and of the vibrations of a tuning-fork.

CLASS 130.

Friction Tubes.—**Electric Fuses and Detonators.**—The charge in the gun is ignited by friction tubes, small cylinders filled with mealed powder, and having a little detonating substance in the end, in contact with which is a surface-roughened metal bar; a sharp pull on the bar detonates the substance and fires the charge. Or by electric fuses or detonators, in which a tube is filled with insulating material through which two copper wires pass; between the inner ends of the wires is placed, wrapped in gun-cotton wool, the platinum wire or composition, according as it is fuse or detonator; the outer ends of the wires are connected up and fired by electricity in the usual way. Electric arrangements are used principally with the heaviest guns, and are indispensable for firing a number of guns simultaneously; they are employed also for firing submarine mines.

Shell Exploders.—Fuses.—Time.—Percussion.—Shells are exploded by fuses, which are of two kinds, time and percussion; the former depend for their accuracy upon the rate at which the fuse composition burns in a closed chamber; this chamber is connected with the *blow* charge of the fuse, which explodes when the burning composition reaches it, firing the powder charge in the shell; the composition in the fuse is ignited by an ingenious contrivance set in action by the shock of discharge of the gun;—the latter explode on striking the object, the arrangements which enable them to do so being modifications of the preceding contrivance. There are other modifications in which it is sought to delay or to accelerate the action of the fuse.

Signal Lights.—Blue Lights.—Light Balls.—Little progress has been made in signal and other lights. They are represented by blue lights, light balls, and parachute lights. The composition and mode of action of these is well known.

Rockets.—War.—It is not necessary to say much of war rockets; their use in war has been almost abandoned, and no progress has been made in their manufacture, the difficulties insuring an intimate union between the case and the composition which it encloses, and uniformity of action, being as great as ever.

Signalling.—Life Saving.—For signalling and life-saving purposes, where the sizes of the small and the cases non-metallic, they are very useful. For signalling, the heads are filled with star lights; for life saving they carry lines secured to the rocket sticks; in these the composition is driven differently, viz., in two portions, or with two cavities.

CLASS 131.

Guns.—Military.—The improvements in small arms are due to the adoption of rifling and breech-loading. Rifling was invented in the 16th century, adopted in the British Army, for a regiments only, about 1800, but did not make progress for a long time owing to the difficulty of making the ball expand to take the grooves of the rifling; a spherical ball with a hard cast upon it was first used, then an elongated bullet, with a hard cup in its base, the bullet expanding by the pressure of the powder gas, and forcing the bullet into the rifle, and length, in 1864, breech-loading was introduced, followed by the conversion of the Enfield to a Snider rifle, and in 1869 the Martini-Henry was introduced, and is still in use.

The barrel is rifled in 7 grooves, with a twist of 1 in 22 inches, the bore is .45 inches, charge powder 85 grains, bullet 480 grains.

In making a Martini-Henry, upwards of 2,000 distinct operations are performed, and correctly that each part is *interchangeable*.

The barrel is formed of a piece of solid mild steel. It is heated, rolled, bored and turned, then tested by sight and gauged, powder proved, rifled, and again powder proved, and finally browned.

The stock is of walnut, in two parts; the wood is tested, desiccated, rough-shaped, and again tested; it is then machined and hand-tested.

The body, in which are the lock and breech action, is of mild steel, it is stamped out of bar, drifted, screwed and milled; the bayonet is a steel blade, welded to an iron bar.

Different nations use different systems; six are in use in Europe, differing mainly in the number of motions and action of the breech; some of these are magazine guns also.

Sporting Guns.—The variety of sporting guns and rifles is great, but the rifles do not differ much in manufacture from the guns; both fire more powder in proportion to weight of ball than military rifles, their object being great accuracy and penetration at short ranges; they are mostly double-barrelled. The main features of improvement are in connection with the lock at the breech, the employment of cartridges, and the abandonment of the cap form of detonation.

Pistols.—Pistols were for long either single or double-barrelled, till Colt revived the revolver. In his form a multi-chambered cylinder revolves horizontally, and as each chamber arrives at the uppermost position it is opposite the barrel, it is then cocked by the thumb, which operation locks it to the barrel, and is fired in the usual way; the trigger was then made to pull the hammer, turn the cylinder and fire by one pull. This was varied, so that the pistol might be cocked and fired in the ordinary way; then the chamber was bored through the breech, so that loading might be done from the rear, and in some forms the cylinder and barrel open on a hinge, throwing out the spent cartridges.

Harpoon guns are used in whale fishing the; projectile is the harpoon, and carries with it a line, the standing end of which is fast to the boat from which the gun is fired.

Air guns are toys; the air is forced into a chamber under a pressure of many atmospheres; the release of this, or of a portion of it, directed upon the base of the bullet, drives it to some distance.

CLASS 132.

Little improvement has been made in swords; the variety of them is great. Military swords are the chief arm of cavalry, and are long, straight, and heavy. A smaller description, sharp-pointed and in part double-edged, is the arm of officers of infantry. Cutlasses are used on board ship; they are shorter and heavier than ordinary swords. Claymores are shorter swords with large basket hilts.

Bayonets have received mention, but there are other and more complicated forms: for shorter arms a longer sword-shaped bayonet is used; in some forms this is designed to act also as a saw, in others as a digging tool.

Lances.—Lances are formidable weapons for cavalry in certain circumstances; the shaft should be strong and light, the point sharp and of fine temper.

Intrenching Tools.—There is great variety of these tools. Some form part of the equipment of the infantry soldier, so that he may have always at hand the means of throwing up hasty cover. The design of these is that each tool, while fit for various purposes, such as digging, shovelling and cutting, may be light and easily carried by the soldier. The intrenching tools which pertain to the equipment of the engineer soldier, and which are used in more permanent works, are the ordinary navvies' tools modified in weight, size, and shape, so that they may be packed in moderate compass and transported readily from place to place.

CLASS 133.

Explosives.—Explosives are of two classes, mixtures and compounds. In the former the ingredients are mixed mechanically, in the latter they are in chemical combination, resulting in an explosive molecule.

Explosive Mixtures.—The mixtures are nitrate mixtures or chlorate mixtures. In the nitrate the oxygen is held so firmly in combination that a powerful disturbing force is needed to separate it. Gunpowder is a representative of this class.

The chlorate mixtures part more readily with their oxygen, and are very sensitive to friction and percussion. They are used for igniting other explosives.

Explosive Compounds.—In explosive compounds the union of the combustible and the supporter of combustion is close, and the action is consequently violent and rapid. They are formed by the introduction of nitric peroxide to some substance containing carbon, hydrogen and oxygen. The new compound is in a state of feeble chemical equilibrium. Gun-cotton and nitro-glycerine, which are both tri-nitro substitution products, are the leading members of this class, but the number of products is very great.

Gunpowder (ignites at 600° Fah.).—Considerable advance has been made recently in the manufacture of gunpowder. The old-fashioned violent gunpowder was suited to S. B. guns of all kinds; but with guns rifled and of increased calibres it no longer produced satisfactory results. When, in order to attain higher velocities, charges were increased, and guns chambered to receive the charges, attention was directed to the more thorough ignition of the powder, and to the mitigation of the violence and rapidity of its action. This led to alteration in the size and shape of the grains, and herein has been the advance, for the ingredients have remained the same, in England at least, with but slight variations in their proportions, for years.

Theoretically the best form for the grains is rounded, the size being suited to the gun.

In addition to rifled large and small grained powders, which still retain their place for the service of small guns, for bursting charges for shells, and to assist in the ignition of larger charges, we now have, leaving aside pellet and pebble, moulded powders, such as prismatic and cylindrical, in which the sizes of the grains vary from one inch to two inches the side or more. In these powders there is no change in manufacture as far as granulation. The granulated powder is pressed into moulds, is pierced with one or more holes and dried; these holes are for the

purpose of exposing more surface to ignition, and of ensuring the more simultaneous and more uniform combustion of the charge.

Variations have been made in the proportions of the ingredients with the object of diminishing the fouling and erosion of the bore, but so far with little success. A powder has been made in which, while the consumption is more thorough, the action is slower and more uniform; this is understood to be due to the addition of a fourth ingredient. This is called cocoa powder.

There are also progressive powders, in which dense grained cake is pressed between layers of lighter powders, and the grains are then formed from this compound cake.

Gun-cotton.—*Compressed Gun-cotton.*—Gun-cotton was known in 1848, but the difficulty of freeing it from impurities rendered it untrustworthy, for under the action of light and heat free acid was developed, tending to spontaneous combustion. It was not until the processes of reducing the fibre after conversion to a finely divided state, and then compressing it into masses, were introduced, that its explosive qualities were brought under control, and its keeping qualities established.

The process of manufacture is simple; the cotton is steeped in strongest nitric acid, sulphuric acid being added to take up the resulting water; the cotton is next washed until no trace of free acid remains; it is then pulped, moulded and compressed. Compressed gun-cotton detonates at the rate of 18,000 feet per second.

Dynamite.—The explosive which has obtained the widest market is dynamite, which is a convenient form of nitro-glycerine, the oil being taken up by an inert and absorbent body. A silicious earth is commonly made use of, which takes up about three times its weight of the oil without becoming moist or yielding up its oil to the touch.

Gun Cartridges.—Charges for fuses are made up into cartridges. In the olden guns the powder was placed in a large bag and tied with what was called a *choke*; in the large modern guns the making up charges is work of great nicety, the grains being disposed symmetrically. In very large charges the cartridge is in several portions, while in very long charges the powder is sometimes arranged round a central tube, or with a central cavity to facilitate the more instantaneous and uniform ignition of the charge. The bag which holds the powder is made of a silken material, which burns without leaving a residue.

Rifle Cartridges.—*Sporting Gun Cartridges.*—In military rifles and sporting guns the cartridge case holds the bullet, and means of ignition, as well as the powder charge; the case is made of solid drawn or other metal, or of milled board.

CLASS 134.

Torpedoes and submarine mines play in aqueous military operations the part which mines do in military operations on land. Torpedoes are offensive, submarine mines are defensive weapons.

Torpedoes: Fish—Locomotive—Towing—Spa or Outrigger.—Torpedoes are of four kinds: 1, the Fish torpedo, which carries its own means of propulsion and charge of explosive, and moves beneath the surface of the water. It may be projected either below the surface or from moderate heights above it; 2, the Locomotive torpedo, which may or may not carry its own means of propulsion, is steered from the shore, paying out as it moves the electric cable, india-rubber tubing, or wire by which it is attached to the shore; 3, the Towing torpedo, which is towed by a vessel in motion and acts by being dragged against its object; 4, the Spa or Outrigger torpedo, which is fixed to the end of a spa and acts by being driven against its object.

1 and 2 are used from the shore as well as from vessels, and their charges are exploded by contact. 3 and 4 are naval weapons, and may be exploded either by percussion or by electricity.

Drifting Mines.—There are also drifting mines, which move with the tide or current, and submarine boats designed to sink beneath the surface of the water and to rise again at the pleasure of the crew.

Submarine Mines.—Submarine mines are cases of explosive substances placed beneath the waters which hostile vessels must traverse when moving to attack. When placed on the bottom they are called ground mines; when floating beneath the surface buoyant mines. Both are in electric communication with the shore, but with incomplete circuit, which when the mines are fired by observation is completed by the observer, or when the mines are fired by contact is

completed by the object itself through the agency of a *circuit closer*; in the latter as in the former case the firing may be optional upon the part of the observer, the arrangements of the circuit closer being then such that contact notifies to the observer the position of the object.

The position of the object when observation mines are employed is ascertained by position finders, *vide* below.

Mechanical Mines.—Submarine mines are also fired by mechanical arrangements upon contact, or after a specified interval of time. The explosive substances employed are usually compressed gun-cotton or dynamite.

Mines are employed in the attack and defence of fortresses and intrenched positions. In the attack the position of the mines is reached by excavation, in which the miners are compelled to work in very confined positions, the galleries and shafts are sheeted with timber, prepared beforehand, and forming part of the equipment of the army; in the defence the shafts and galleries are permanent structures built with the fortress.

A more rough method is used in intrenched positions; bottles or small cases filled with violent explosives are placed below the surface and arranged to go off, especially at night, by the pressure of bodies moving on them; they may also be fired by electrical means.

For laying out submarine mines specially fitted vessels are employed.

CLASS 135.

Range-finders.—The range of guns and small arms has so extended, and has become so accurate, that in action firing commences at long distances from the object aimed at, and without some simple means of ascertaining distances much ammunition will be expended uselessly.

Various instruments have been devised for the service of artillery and infantry, and are called Telemeters, Range-finders, and Position-finders.

For artillery in the field or at sieges, Telemeters or Range-finders are made use of.

For the service of fort artillery, Range-finders and Position-finders are employed; the latter are used for submarine mining purposes also.

Telemeters.—**Trigonometrical.**—Telemeters are devised on three systems. 1. The trigonometrical, in which a base and two angles are known; in some the base forms part of the instruments, in others the base is measured and the angles observed; an advantageous modification is when the base, as with some instruments, is determined by a subsidiary triangle, or when the base is a given proportion of the range. The instruments employed are theodolites, sextants, and reflecting mirrors and prisms.

Acoustic.—2. The acoustic, in which the time between the flash of gun and report of projectile is noted; in this no range can be ascertained until firing commences.

Optical.—3. The optical, in which the range is ascertained by observation of the size of distant objects as seen in a telescope.

The essentials of Range-finders for the field are that, not requiring the service of more than one man, they shall be accurate, simple, portable, and durable.

Position-finders.—For fort and siege artillery better and more complex instruments may be resorted to, because more time can be devoted to the instruments, and more choice exercised in the selection of a base, the trigonometrical system being employed; but where the fort defends open waters, Position-finders should be used; these, as their name signifies, indicate at any time the position of the ship or object to be aimed at. These instruments depend upon the principles of similar triangles; the terrain to be defended is mapped to scale and divided into squares, the positions of the observing stations are mapped, and are placed in electric communication with the observing stations themselves; as the observers from these stations follow, each with his telescope, a moving object-pointer, pivoted on the stations, points on the map move automatically with the telescopes, the intersection of the pointers indicates on the map the position, distance as well as direction, of the object; the range and distance of each square of the map is tabulated, and with every gun that bears upon it; the position of the object is communicated electrically to these guns, which can then be fired either by the observer or in the battery.

This method is used for submarine mines, but their position being known are mapped, and the object is followed by the observers until it is over a mine, when the mine, which is in electric communication with them, may be fired or not, at the pleasure of the observer.

In another form of Position-finder the base is vertical, and there is but one observer, who himself ascertains the position of the object by an angle of depression; this is a very simple method, and depends upon the properties of right-angled triangles; it is only applicable when the base bears some sensible proportion to the distance of the object. It is called a Depression Position-finder.

CLASS 136.

Military Equipment.—The different military equipments are designed for the service in the field of a considerable *body* of men, generally a complete unit, such as an Army Corps, the intention being that each, while sufficiently mobile to accompany this *body*, as may be necessary, shall be in itself complete. Each equipment is on wheels, and something in the matter of efficiency or convenience has to be sacrificed to mobility.

Photographic.—In the photographic equipment will be found all that is necessary for a moderate service. The wagon is fitted as an office, and has cameras and printing frames 12"×10" and 7½"×5", for rapid and stereo lenses; it has also baths, chemicals, and paper, and everything necessary for printing.

Telegraphic.—The telegraphic equipment is more extensive and more mobile; it has to accompany an army on the march, and it carries on numerous wagons from 60 to 100 miles of light telegraph cables or copper wire, according as the line of telegraph is ground or air; it has of course batteries, galvanometers, recording instruments, sounders, polarised relays, lightning conductors, and all instruments necessary for adjusting and repairing the same. This equipment has offices fitted up in its wagons.

Pontoon.—Pontoon equipment is carried by armies in the field to enable them to pass over water; it consists of pontoons, boats having similar decked ends and partly decked sides, saddle beams, saddles, and chesses. The buoyancy is provided by the pontoons, which are placed at suitable intervals apart, the roadway by the chesses. The pontoons are moved from place to place on wagons, each wagon carrying a pontoon and the superstructure of one bay, besides anchors, buoys, cables, boathooks, oars, and such other stores as are necessary for boating purposes. The pontoons are used singly as boats, or in pairs as rafts. They are made of timber framing covered with pine, sandwiched between two layers of canvas with indiarubber solution, and payed over externally with marine glue; they are made also of metals and of other materials, and of various shapes.

Mining.—Mining equipment consists of the timbering for shafts and galleries,—ordinary miners' tools modified to meet military purposes, viz., shovels, picks, candlesticks, buckets, and trucks, boring and blasting tools, bars, jumpers, scrapers, needles and sledges; means of ventilation, such as bellows, blowers and fans; respiratory apparatus; and means of lighting and firing, such as fuses, detonators, dynamo machines, electric batteries.

Signalling.—Each regiment has its own signalling equipment, which is very simple, consisting primarily of flags, lamps, and message books. In addition, heliostads, heliographs, and shutter apparatus are made use of when opportunity serves; they are based upon the reflection of rays of light from a polished surface, and can, under suitable conditions of sun and atmosphere, convey messages to great distances.

Hospital.—This provides all that is necessary for ministering to the comfort of the sick and wounded in action or at the base hospitals, or in their removal to places of security.

Transport Service.—This comprises commissariat and ordnance transport; in the former, all that is necessary to prepare the food of men and animals of an army in the field should be found; e.g., bakery and butchery carts, steam travelling ovens, machines for making and roasting coffee, instruments of measure, &c., &c. In the latter, everything connected with munitions of war, the fitting out of buildings and hospitals used temporarily by the troops in the field, &c., &c. All these Equipments carry, in addition to their special stores, sufficient of ordinary camping and intrenching stores for their own purposes.

GROUP XXV. — FIRE-ARMS: MILITARY WEAPONS AND EQUIPMENT; EXPLOSIVES.

For Fortification, see Group III.; for Torpedo Boats, see Group VII.; for Special Articles mentioned under "Military Equipments," see also respective classes.]

Nos. 1882-1931.—SOUTH GALLERY, MIDDLE COURT.

1882. WAR DEPARTMENT.

ROYAL GUNPOWDER FACTORY, WALTHAM ABBEY.—(1) Case, showing by models the successive stages of the progress made in the manufacture of the various kinds of service gunpowders since 1862. Also Specimens illustrating the manufacture of compressed gun-cotton [Abel's system] for submarine mining and Royal Engineer field and siege purposes. (2) Lamps, Electric, with water jackets, as used for illuminating the interior of buildings in which gunpowder manufacture is carried on. (3) Models of largest Cartridges used in 1862 and 1885.

ROYAL CARRIAGE DEPARTMENT, WOOLWICH.—(1) 12-Pounder Gun, hydraulic equipment, complete. (2) Portable Forge for military service. (3) Hydraulic Lifting Jack.

ROYAL GUN FACTORIES, WOOLWICH.—(1) 8-inch B. L. Gun, complete. (2) 20-inch Trepanning Bar, 16 feet long, with tools and specimens. (3) 12-Pr. Field Gun. (4) 5-inch Tangent Sight, showing stages of manufacture, illustrated by about ten operations in succession. (5) 6-inch Tangent Sight, showing stages of manufacture, illustrated by about ten operations in succession. (6) Automatic Clamp parts showing processes of manufacture. (7) 6-inch Percussion Lock, showing processes of manufacture with different operations following in succession; also springs, detents, and parts. (8) Bronze Sight Crosshead—casting and machined. (9) 6-inch Carrier Ring and parts—forged, machined, and completed. (10) Compound Turret Sight, complete. (11) Breech End Frame and Model Breech of 6-inch guns, with appurtenances and safety-apparatus complete.

Descriptive Statement regarding Royal Gun Factory Exhibits.

(1) 8-inch B. L. Gun of 12 tons, Mark III.—This gun is constructed entirely of steel. It consists of an inner core or barrel, upon which are shrunk a breech piece and front hoop. Upon these are shrunk the trunnion ring and a tier of breech hoops. The thread for breech screw is cut in the breech piece, and is interrupted in four divisions. The obturation is on the De Bange principle, with asbestos wad, tin discs, and steel bearing rings. The gun is vented through the rear, the vent spindle having a large head which serves to transfer the pressure of discharge to the obturator, which is thus

compressed against the breech screw end, and by its elasticity is enabled to expand with sufficient determination against the walls of the chamber to seal the escape of gas under the heaviest pressures. The charge is fired by a vent-sealing percussion tube ignited by a firing lock, or by electric current. The breech-screw can be released or tightened up by a quarter turn effected by the hinged lever, which is acted upon by the Stanhope lever arrangement and ratchet gear. This latter was applied in contemplation of great power being necessary to work the screw after firing; it is found that with this nature of gun and under, this auxiliary means is not required, but it has been allowed to remain upon the exhibit to illustrate the method used for working the screws in the large guns where only manual power is available. The screw during loading is withdrawn from the gun upon the bronze-hinged carrier. The adhesion of the obturator to the chamber after firing is overcome by the cam of the hinged lever, which also locks the breech after loading when the lever falls down, and the cam enters a recess cut in the breech to receive it. The gun fires a charge of 105 lb. of Cocoa powder. The weight of projectile is 210 lbs. Muzzle velocity of projectile, 1970 f.s. Velocity at 1000 yds. 1805 f.s. Penetration of armour at muzzle, 16.3 inches. Penetration of armour at 1000 yards, 14.2 inches. The bore is 8 inches diameter, and the length of bore is 204.9 inches. The powder chamber is 10.5 inches diameter, and 34.5 in. long. The gun is rifled with 32 grooves, the twist increasing from 1 turn in 120 calibres at breech to 1 turn in 35 calibres in a distance of 97.7 inches, half the length of rifle grooves, the twist for the remaining half being uniform.

(2) 20-inch Trepanning Bar.—This is a boring tool for removing material in form of a solid core instead of entirely in shavings or turnings as is usually done. It consists of a hollow steel cylinder about $\frac{3}{4}$ inch in thickness, the working of which is furnished with a number of small cutting tools. These do not each cut the entire width of the kerf intended, but only a portion of the width; but they are so arranged as to overlap each other's work, and thus the entire width is made. The inner grooves convey streams of water which is forced under high pressure to the tools, and not only lubricates and preserves the cutting edges of the tools, but forces out all the cuttings which are carried with the return streams of water along the exterior grooves of the bar. The bar is fixed and the subject of operation revolves. The speed of advance of the tool is about 3 inches per hour. The inner cores which are removed become available for employment in various directions. Solid cores as long as 32 feet have been brought out in one by this method.

(3) 12-Pr. Field Gun.—This gun is made wholly of steel, and consists of an inner barrel upon which is shrunk and locked a breech jacket, to which are forged the solid trunnion arms of the gun. Its weight is 7 cwt. nominal.

The breech mechanism consists of an interrupted screw with hinged lever and De Bange obturation. The gun is radially vented, and is fitted with a safety marking slide which prevents the insertion of the friction tube while the breech is open. The gun is chambered to 3.625 inches diameter, and to a length of 11.2 inches. The calibre is 3.0 inches. It is rifled with 12 grooves, having an increasing twist from 1 turn in 120 calibres to 1 turn in 28 calibres. The charge is 4 lbs. P. powder. Projectile, 12.5 lbs. Muzzle velocity, 1705 f. s. Velocity at 1000 yards, 1247 f. s.

(4) Tangent Sights for 5-inch and 6-inch guns.—The two star devices in the case show the processes of manufacture of these sights from the forging to the finished article. They exhibit the several operations required which are principally carried out by milling machines. The strips on which the graduations are recorded are of aluminium crown metal, and in the 5-inch sights are riveted by the bar, but in the head section bar of the 6-inch gun they are removable from the grooves into which they slide, so that, in the event of a change in the range tables, new strips can be readily inserted without trouble or exchange of sight. The graduations are all stamped in by suitable dies at one operation on each strip.

(5) Automatic Clamps for the above Sights.—The several parts and operations connected with their production are exhibited. The clamp is a small friction peak which, while it permits of the ready adjustment of the sight at any moment when a change of elevation is required, yet immediately clamps the sight automatically on removal of the man's hand, and prevents the sight from either falling or rising under the shock of discharge.

(6) Percussion Firing Lock for B. L. Gun.—The various processes from the forgings to the finished details and assembled lock are here shown. The forgings are all made of the best tool steel; they are stamped in dies, and the several operations shown are, with one or two exceptions, performed in milling machines. All that is required in the final finishing and adjustment is a minimum of hand labour.

(7) Bronze Sight Crosshead.—A simple casting and the machined article are shown; the stem is bored, and turned in a lathe. The shaping of the head is done at one setting in one machine.

(8) 6-inch Carrier Ring.—A forging, a mechanical ring, and a finished carrier ring and details are exhibited. They illustrate the value of refined machine work in the production of interchangeable details.

(9) Compound Turret Sight.—This is a form of sight which has been introduced for Turret service in H.M. Navy. It consists of an inner bar set at the required angle to correct deflection of projectile due to rifling, upon which are graduated the several ranges for various charges. The inner bar fits within an outer bar of large section and length, within which it can be adjusted and clamped. This outer bar works

within a socket attached to the roof of the turret, and is adjusted by a wormwheel and endless screw worked by a hand wheel conveniently placed for the captain of the turret. The outer bar is placed at right angles to the plane of turret revolution, and the working is as follows:—The required range having been determined, the inner bar is raised and clamped. This sight is laid upon the foresight of turret and the object, and brought into action by the hand-wheel which is turned by the man as required. The elevation for the gun is recorded by the indicator, which is attached to the lower end of the outer bar, and which reads with scale of degrees on the lower guard tube. Directly the sight is laid, the gun crew inside the turret at once see the elevation required, and set the gun accordingly. It will be observed that this arrangement makes all the requisite compensations for deflection of projectile and keel of ship without mental efforts on the part of the men using it.

(10) Model Breech of the 9.2-inch B. L. Gun.—This consists of a service bronze end frame attached to a model representing a portion of the breech of the gun. The frame is fitted with a hinge carrier ring which receives the breech screw when withdrawn from the gun. The screw and ring are swung to the side of a worm-wheel arrangement worked by a convenient handle. This permits the working of the mechanism in a heavy seaway, or at extreme angles of elevation. The gun is fitted with Stanhope lever arrangement for turning the screw, and with percussion and electric firing apparatus.

ROYAL LABORATORY.—(1) 12-inch Breech Loading Cartridge, complete; Common Shell, section, filled and fuzed Direct Action fuze; Shrapnel Shell, section, filled and fuzed; Palliser Shell, whole; Case Shot. (2) 68 Pr. Smooth Bore [as in service in 1862]. Cartridge 18 lb. complete; Shell, Common, section, filled, with Pettmann Land Service fuze; Shell, Diaphragm, section. (3) 7-inch R. B. L. Cartridge 14 lb. [without paper cylinder]; Shell, Common, section, filled, and Pettmann General Service fuze. Shell, Segment, section, filled, and time fuze. (4) Small Arm Ammunition, whole and section of all, in box. (5) Machine Gun Ammunition, whole and section of all, in box. (6) Fuzes—Time, wood, 15 in. Muzzle Loading; time, wood, 15 in. with detonator; time, wood, 30 inch M. L.; metal, Armstrong, time and concussion; medium; percussion, Pettmann G. S. and Land Service; direct action; R. L.; B. L. plain. [Whole and section of each]. (7) Tubes—Electric, Nos. 4, 10, 11, 17; Friction, Service, long; Friction, Service, short; 7 Pr.; Quill, long; Quill, short; Time Gun; Vent Sealing, Electric, V. M. P.; Vent Sealing, Friction, V. M.; Vent Sealing, Percussion. [Dummy].

ROYAL SMALL ARMS FACTORY, ENFIELD LOOK.—Machine Guns [with ammunition—Dummy].—(1) Four Barrel Nordenfelt—1-inch gun. (2) Five Barrel Nordenfelt—4.5-inch

gun. (3) Five Barrel Gardner—45-inch gun.
(4) Two Barrel Gardner—45-inch gun.

Small Arms—Firearms [with ammunition—Dummy].—(1) Martini-Henry Rifle, Mark II., with Long Bayonet. (2) M.-H. Rifle, Mark III., with Sword Bayonet. (3) M.-H. Carbine, Artillery, with Sword Bayonet. (4) M.-H. Carbine, Cavalry. (5) Snider Long Rifle, with Bayonet. (6) Snider Short Rifle, with Sword Bayonet. (7) Snider Artillery Carbine, with Sword Bayonet. (8) Snider Cavalry Carbine. (9) Enfield Revolver. (10) Instantaneous Fuse Pistol.

Small Arms—not Firearms.—(1) Six Lances. (2) Six Boarding Pikes. (3) One Household Cavalry Sword, long. (4) One Household Cavalry Sword, short, for band. (5) One Sword, Cavalry Pattern 1864. (6) One Sword, Cavalry Pattern 1882. (7) One Sword, Cavalry Pattern 1885. (8) Four Staff-Serjeants' Swords. (9) Four Drummers' Swords. (10) One Naval Cutlass. (11) Two Cuirasses.

Miscellaneous.—(1) One Case containing Components of Rifle, Bayonet, &c., in various stages, to exemplify process of manufacture. (2) Diagrams showing the trajectories at various ranges, from different rifles.

ROYAL ENGINEERS ESTABLISHMENT, CHATHAM.—Submarine Mining.—(1) Test Table, complete, with batteries, telephones, and all apparatus. (2) Electro Contact Steel Spherical Case, Mark II., complete, with apparatus, moorings, &c., suspended. (3) Ground 250 lb. Mine, with steel circuit closer, complete, and suspended. (4) Electric Light Apparatus, complete, with projector, mirror, &c. (5) Models of Mines, &c.

R. E. Field Equipment.—(1) Models of Bridges, Pontoons, &c. (2) Wagon Cover Tent.

Balloon Equipment.—(1) Balloon, inflated in the air. (2) Tubes, Gas, two or three specimens. (3) New Limelight for Search and Signalling.

Photographic Apparatus.—Apparatus for releasing shutters of cameras at definite intervals of time.

Electrical Apparatus.—(1) Cable Batteries and Instruments, 6 cells, Lalande and Chaperon, School of Military Engineering Pattern. (2) Shunted Galvanometers. (3) Apparatus for firing mines. (4) Field Test Box.

Electric Light.—(1) Cheap Bent Mirrors. (2) Cardew's Voltmeter.

Signalling.—Heliograph.

Survey Instruments.—Various.

1883. **ARMSTRONG, SIR W. G., MITCHELL, & CO., Limited, Elswick Works, Newcastle-on-Tyne.**—Models and Drawings illustrating modes of mounting heavy guns.

1884. **ADMIRALTY, LORDS COMMISSIONERS OF, Parliament Street, London, S.W.**—NAVAL TORPEDO SERVICE: (1) Gun Tubes and Detonators. (2) White-head Torpedo, Mark I. or II. R. L. (3) Section of Torpedo. (4) Naval Mine Cases empty

[sealed up], not to be opened, 500 lbs. and 72 lbs. (5) Single Cell Test Battery. (6) Six Cell Test Battery. (7) Three Cell Firing Battery. (8) Ten Cell Firing Battery. (9) Pistols, Gun Metal. (10) Wheatstone's Balance. (11) Firing Key, Mark IV. (12) Test Coil. (13) Marine Galvanometer. (14) Scale for Marine Galvanometer, with Lamp. (15) Shunt for Marine Galvanometer. (16) Space for Focusing. (17) Firing Resistance Coil. (18) Mark Buoy. (19) Outrigger Model on stand. (20) Diving Telephone, complete in box. (21) Submarine Lamp. (22) Diving Helmet and Breast Rope.

1885. **NORDENFELT, T., 53 Parliament Street, London, S.W.**—(1) New Electrical Torpedo. (2) Quick-firing and Mountain Guns. (3) Mitrailleuses, their Carriages for field and naval service. (4) Saddles, Fuses, and Ammunition. (5) Magazine Rifle and Bayonet.

1886. **HOPE, LIEUT.-COL. W., V.C., Army and Navy Club, Pall Mall, London, W.**—The Hope Gun and Ammunition.

1887. **HOTCHKISS & CO., 49 Parliament Street, London, S.W.**—Guns and Ammunition.

1888. **MAXIM GUN CO., Limited (THE), 57d Hatton Garden, London, E.C.**—The Maxim Machine Gun.

1889. **MALET, LIEUT. - COL. H., C.E., 21 Cockspur Street, London, S.W.**—Improvements in the construction of Gun Carriages.

1890. **JONES, MAJOR J., R.E., Park Side, Wellington Road, Alexandra Park, Manchester.**—(1) Model of Revolving and Self-balancing Iron Shield for the protection of guns in casemates, open batteries, &c. (2) Photograph of Water Cart for field service. (3) Hand Grenades for land and sea service, and for construction of rifle pits, &c.

1891. **STOREY, ALBERT H., 38 Lindore Road, Wandsworth, London, S.W.**—Improved Army Trenching Tool.

1892. **CLARK, E. H., Ilex House, Starcross, Devon.**—Great Gun Equipments.

1893. **SUFT, LIEUT. H. C., Munster Lodge, Fulham, London, S.W.**—Automatic Safety Catch for Martini-Henry rifle, &c.

1894. **MILLER, HERBERT PERCY, 121 Fleet Street, London, E.C.**—(1) Dial Sighting Scale for measuring and regulating the sighting elevations of rifles. (2) Gauge for measuring and drawing aim lines on the back sights of rifles. (3) Aperture Shooting Spectacles for defining and securing accuracy of aim.

1895. **BAYLY, J. PITT, C.E., M.S.A., 18 Fulham Place, Paddington, London, W.**—(1) Improvements in Ordnance for

Breech Loading Field and Garrison Guns. (2) A Working Model of a 9-Pounder Field Gun, one quarter full size.

1896. **QUILLIAM, THOMAS, 49** Westfield Road, Hornsey, Middlesex.—Patent Cartridge Magazine, for keeping cartridges for right and left barrels separate, and giving the greatest facility for quick firing, a simple pressure on finger piece giving the cartridges desired. Is perfectly weather proof, there being no exposed opening during extraction.

1897. **JOYCE, F., & CO., 57 Upper** Thames Street, London, E.C.—Bailey's Improvements in Cartridges.

1898. **PIGGOTT BROTHERS, 59, 58 & 57** Bishopsgate Street Without, London, E.C.—(1) The Wolseley Field Officers' Tent. Made with an inside lining, and partitioned off to form bedroom and sitting-room. (2) Portable Camp Fittings.

1899. **NOBEL'S EXPLOSIVES CO., Limited, 149** West George Street, Glasgow.—(1) Dynamite and Blasting Gelatine. (2) Detonators. (3) Electric Fuses.

1900. **SCHULTZE GUNPOWDER CO., Limited (THE), 32** Gresham Street, London, E.C.—Schultze's Patent Smokeless Gunpowder.

1901. **BLAND, THOMAS, & SONS, 106** Strand, London, W.C.—(1) Patent Explosive Bullet for big game shooting. (2) improvements in Cartridge Cases. (3) Nordenfelt Breech Action applied to Fowling Pieces. (4) Harpoon, with explosive attached. (5) Improvements in Harpoon Guns. (6) Improvements in Punt Guns. (7) Improvements in Guns and Rifles.

1902. **ELEY BROTHERS, Limited, 254** Gray's Inn Road, London, W.C.—Sporting and Military Ammunition.

1903. **WILLIAMS, ROBT. THOS.,** Frome, Frome.—Improved Signals, Mantlet and Target for rifle practice.

1904. **THORNTON DE MOUNCIE, BARON A., 22** Sackville Street, Piccadilly, London, S.W.—Improvement in Firearms.

1905. **ROWELL, G., M.D., Falcon** Road, London, S.W.—(1) Section of Blast Furnace, Settling Pool, and Casting Mould [Drawing]. (2) Diagram showing gun-casting. (3) Model of Spiral Sigmoid Rifling. (4) Model of Spiral Sigmoid Choke-bore Rifling. (5) Spiral Sigmoid [Fish-tail] Projectiles. (6) Double Chisel-headed Projectiles. (7) Rifle Sights. (8) Cartridge.

1906. **STYLES, T. G., & CO., 8, 9, 10,** Weaman Street, Birmingham.—Improvements in the manufacture of breech-loading hammerless guns.

1907. **NOKES, WM.,** Chester Street, Aston, Birmingham.—Automatic Safety Gun.

1909. **BURTON, BETHEL (MESSRS. OASLER, PALMER, & CO.),** Market Street, Bermondsey, London, S.E.—(1) Sporting and Military Magazine Rifles. (2) Improved Safety Cartridges and Cartridge Reloader. (3) Improved Bayonet for Rifles.

1910. **PATSTONE, JOHN, 25** High Street, Southampton.—(1) Snap Action to Breech-loading Guns of all kinds. (2) Wild Fowl Guns, Revolvers, &c.

1911. **PERKES, THOMAS, 70** Osna-burgh Street, Regent's Park, London, N.W.—The Universal Hammerless Sporting Gun.

1912. **WOODWARDS, JAMES, & SONS, 64** St. James's Street, London, S.W.—Improved Automatic Patent Hammerless Safety Gun.

1913. **DUNCAN, J. W.,** Paul Pry Works, New Summer Street, Birmingham.—Patent Express Choke Gun.

1914. **TURNER, THOMAS, 19** Brook Street, London, W.; and 6 Fisher Street, Birmingham.—(1) The Featherweight Gun. (2) Patent Attachable Muzzle. (3) Intercepting Safety Arrangement for hammerless guns. (4) Patent Semi-Hammerless Gun.

1915. **GILBERT, THOMAS, 54** Great Marlborough Street, London, W.—(1) Shooting Corrector. A simple device for shooting with both eyes open, attachable to guns, rifles, or ordnance, of any size or construction.

1916. **CREDENDA COLD DRAWN SEAMLESS STEEL TUBE CO. (THE),** Ledsam Street, Birmingham; and Water Lane, Great Tower Street, London, E.C.—Cold Drawn Seamless Steel Tubes.

1917. **RIGBY, JOHN, & CO., 72** St. James's Street, London, S.W.; and 24 Suffolk Street, Dublin.—(1) Patent Improved Safety Bolt for hammerless guns and top rib connection with vertical bolt. (2) The V. W. H. Patent for improvement of the manufacture of india-rubber recoil pads with bevelled edges for gun-stocks.

1918. **BLAKENEY, MAJOR W. A. F. (care of MESSRS J. LECKIE & CO.), 12** St. Mary Axe, London, E.C.—(1) Patent Pad Equipment for infantry soldiers. (2) Waterbottle, Entrenching Tool, and General Service Helmet.

1919. **KNIGHT, E. M., 76** St. Domingo Vale, Everton, Liverpool.—Improvements in Filters and Filtering Medium.

1920. **AHRBECKER, H. C., & SON, 117** Stamford Street, London, S.E.—Locomotive Battery.

1921. ANDERSON, W. L., 1 Sydney Villas, Melbourne Road, Wallington, Surrey.—Muzzle Pivoting Gun, comprehending the entire closing of the port, with a separate aperture for the purpose of sighting.

1922. EASTON & ANDERSON, 3 Whitehall Place, London, S.W.; and Brith Iron Works, Kent.—Working Model of Moncrieff Hydro-pneumatic Gun Carriage Mounting a 10-inch 18-ton R. M. L. gun, and sundry photographs of different types of Disappearing Carriage.

1923. KYNOCH, G., & COMPANY, Limited, 199 Piccadilly, London, W.; and Lion Works, Witton, near Birmingham.—The Perfect Metallic Cartridge.

1924. BURGESS, WILLIAM, Berry Lodge, Malvern Wells, Worcestershire.—(1) Springless Alarm Gun. (2) Alarm Gun for military outpost. (3) Hammerless Fowling Piece, central fire.

1925. PAULSON, R., Boon Hills, Langwith, Nottinghamshire.—(1) Improved Military and Sporting, Magazine or Repeating Rifles, Guns, and Pistols.

1926. LANCASTER, CHARLES, 151 New Bond Street, London, W.—Machine [hand power] in operation showing the method of rifling on the celebrated non-fowling smooth oval bore system, for rook, rabbit, express, large bore, and military rifles.

1927. LANG, J., & SON, 22 Cockspur Street, London, S.W.—(1) Improved Safety Device for small arms. (2) Guns. (3) Rifles for sporting purposes, with special rifling to prevent fouling.

1928. WATSON BROTHERS, 4 Pall Mall, London, W.—(1) Improvements in Hammerless Sporting Guns, whereby greater safety and ease of manipulation is obtained, and the process of manufacturing the barrels for same [Tranter's Patents]. (2) Concentric Steel barrels, obtaining greater uniformity and largely increased shooting powers. (3) A Breech-loading Automatic Cannon.

1929. HOLLAND & HOLLAND, 98 New Bond Street, London, W.—(1) The London New Breech-loading Duck Gun for punt use. (2) Patent Climax Safety Hammerless Gun. (3) Improved System of Rifling as applied to sporting rifles, non-fowling. (4) Patent Hammerless Rook Rifles. (5) Improved Harpoon Gun and Harpoons. (6) Patent Magazine Repeating Rook Rifle. (7) Patent Single Express Rifle.

1930. REILLY, E. M., & CO., 16 New Oxford Street, and 277 Oxford Street, London; and Paris.—(1) Hammerless Guns and Rifles. (2) Self-extracting Guns. (3) Central Fire Guns, low hammers. (4) Special Pigeon Guns. (5) Wild Fowl Guns.

(6) Express Double Rifles. (7) Revolvers. (8) Leather Gun Cases and Sporting Implements.

1931. COGSWELL & HARRISON, 142 New Bond Street, and 226 Strand, London, W.C.—(1) Victor Hammerless Guns with improved locks, cocking action, and safety. (2) Farmer's Hammer Gun. (3) Colonist Rifle. (4) Colonist Revolver. (5) Military Rifles and Sights. (6) Verniers for rifles. (7) Metropolitan Police Revolvers. (8) Army Self-extracting Revolver. (9) Ammunition.

Nos. 1932-1954—SOUTH GALLERY, NORTH COURT.

1932. MAIGNEN, P. A., 32 St. Mary-at-Hill, Eastcheap, London, E.C.—Filters for military and hospital equipment.

1933. COPEMAN, EDWARD S., 4 Victoria Street, Westminster, London, S.W.—Bullet Shields for protection of field guns in action.

1934. DICKSON, WILLIAM, Quartermaster 24th Mx. R.V., Post Office Regiment, 14 Old Change, London, E.C.—(1) Rapid Ration Distributor. Will supply 500 men with rations in seven minutes. (2) Improved Circular Arm Rack, provisional patent, specially adapted for use of troops when in camp. (3) Bracket and Shelves [self-fixing grip], for fixing to poles, pillars, or other uprights, in shops or warehouses, for show of goods.

1935. GERELOT & CO., & GAUPILLAT & CO. (SOCIÉTÉ FRANÇAISE DES MUNITIONS), 11 Queen Victoria Street, London, E.C.; & 30 Rue Notre Dames des Victoires, Paris.—The New System of Recapping Cartridges, and numerous other improvements in sporting and military ammunition.

1936. BERTHON, REV. E. L., Romsey, Hants.—Patent Tents, without poles or ropes.

1937. BAXTER, CAPTAIN J. C., R.E., Colchester, Essex.—Cooking Apparatus for military and other purposes.

1938. GALLWEY, SIR RALPH P., BART., Thirkleby Park, Thirsk, Yorkshire; & 30 Eaton Square, London, S.W.—(1) A New Game Register for shooters. (2) A Complete Wild Fowl Shooting Equipment, consisting of a double-barrel breech-loading swivel gun (the first made), and a fowling punt and its belongings ready for use.

1940. BOWRING, ARUNDEL & CO., 11 & 12 Fenchurch Street, London, E.C.—The Combination Pack Saddle, Boxes and Bedstead.

1941. NEEDHAM, GEORGE HENRY, 7 Cologne Road, New Wandsworth, London, S.W.—Full-cock Rebounding Breech-loading Gun.

1942. HAWKER, SEYMOUR, 17 Marlborough Road, Gunnersbury, London, W.—Self-reloading Repeating Firearms and Ammunition.

1943. NEEDHAM, J., 6 Hammer-smith Terrace, London, W.—Ejecting Double Hammerless Sporting Breech-loaders.

1945. PAIN, JAMES, 121 Walworth Road, London, S.E.—(1) Patent Distress Signals. (2) Blue Light. (3) Gamekeeper's Identifiers. (4) Flash Lights for fishing fleets. (5) Smoke Rockets for testing drains.

1946. WATKIN, MAJOR H., R.A., Royal Gunpowder Factory, Waltham Abbey, Essex.—(1) Position Finder for forts and submarine mines. (2) Elevated Batteries, Depression, Artillery Field & Infantry Range Finder. (3) Chronograph for taking velocities of projectiles. (4) Chronograph tracing path of projectiles in the bore of a gun and recoils. (5) Electric Light and Sand Time Glass for powder factories. (6) Electric Position Finder. (7) Clinometer for laying guns, &c. (8) Apparatus for military surveying.

1947. MALET, LIEUT. - COL. HAROLD, 18th Hussars, Royal Barracks, Dublin.—(1) Bale Suspender, for the immediate release of the animal by its own pressure. (2) Carbine or Rifle on back, and sword on saddle or man attachment.

1948. WALLACE, MAJOR N. WILLOUGHBY, 3 Eastern Villas, Southsea, Hants.—(1) Military Entrenching Spade. (2) Pioneer and Ordnance Survey Spades. (3) Portable Pioneer Saw, Grapnel and Outlass Hilt.

1949. WELDON, FRANCIS, LT.-COL., Erlmount, Earley, Reading.—Range Finder [Prism], for surveying, military and sporting purposes.

1950. ATKINSON, JOHN E., 33 Egerton Road, Greenwich, London, S.E.—Improved method of stowing and discharging torpedoes from torpedo boats and other vessels.

1951. GREGORY, WILLIAM, 51 Strand, London, W.C.—The Elcho Range Finder. For ascertaining the distances of troops [infantry and cavalry] in the field from distances varying from 200 to 2800 yards. An observation can be taken in five seconds, and no calculation is required.

1952. MOLE, ROBERT, & SONS, Granville Street, Birmingham.—(1) Improvements in Swords, Scabbards, and Matchets. (2) Presentation Swords of new designs.

1953. SAWYER, LIEUT.-COL. E., St. George's House, Hinton St. George, Somerset.—Revolving Gun Carriage on rails.

1954. JOEL, HENRY FRANCIS, Tower Chambers, Moorgate Street, Lon-

don, E.C.—Protecting Ships and Sea Force from Torpedoes.

ADIE, PATRICK, 15 Pall Mall, London, S.W. (See Group XXVIII.)

ANDERSON, R. F., C.E., 84 Commercial Street, Dundee. (See Group II.)

EVERY, W. & T., Digbeth, Birmingham; and 14, 15 & 16 Cow Cross Street, London, E.C. (See Group II. Queen's Gate Annex.)

BARRETT, G. J. T., 253 East Road, Islington, London, N. (See Group VII.)

BICKFORD, SMITH, & CO., Tucking Mill, Cornwall; and 85 Gracechurch Street, London, E.C. (See Group II.)

BRABY, JAMES, Maybanks, Rudgwick, Sussex. (See Group IV.)

BRITISH AND FOREIGN MARINE INVENTIONS COMPANY, Limited (THE), 3 Threadneedle Street, London, E.C. (See Group XIII.)

CLARK & STANLEY, Pen-llwy, Chester Road, Wrexham. (See Group II.)

COLLINGHAM, R. M., Green Lane Foundry, Hull. (See Group XI.)

EASTON & ANDERSON, 3 Whitehall Place, London, S.W.; and Epsom, Kent. (See Group XI.)

ELLIOTT'S PATENT MINING PICK CO., Limited (THE), 32 Kennedy Street, Manchester. (See Group I.)

GIBBONS, C. K., 27 Chopping Street, Newcastle-on-Tyne. (See Group VI.)

HOW, JAMES, & CO., 73 Farringdon Street, London, E.C. (See Group XXVIII.)

KERR, STEWART, & CO., 20 Bucklersbury, London, E.C. (See outside South Promenade.)

MACKENZIE & BROUGHAM, 11 Great George Street, Westminster, London, S.W. (See Group XIII.)

MALET, LIEUT.-COL. HAROLD, 15th Hussars, Royal Barracks, Dublin. (See Group VI.)

MERRYWEATHER & SONS, Greenwich Road, S.E.; and 63 Lombard Street, London, W.C. (See Group II. Queen's Gate Annex.)

ORCHARD, JOHN, 100 High Street, Kensington, London, W. (See Group XIV.)

PATERSON & COOPER, 76 Little
Britain, London, E.C. (See Group XIII.)

PHOSPHOR BRONZE CO., Limited
(THE), 87 Sumner Street, Southwark,
London, S.E. (See Group II.)

PIERNE, L., & CO., Limited (THE),
Glasgow Iron Works, Glasgow. (See
Group IV.)

PRESTON, JAMES HENRY, 406
Aldersgate, London, W.C. (See Group
VIII.)

PRIDMORE, ALFRED S., Holmwood,
Surrey. (See Group XVI.)

UNITE, J., 291 & 293 Edgware
Road, London, W. (See Group I.)

WATKIN, MAJOR H., R.A., Royal
Gunpowder Factory, Waltham Abbey,
Essex. (See Group III.)

WILKINS, T., 3 Meredith Street,
Clerkenwell, London, E.C. (See Group
XXVI.)

WILLIAMS, T. H., 23 Stamford
Street, Blackfriars, London, S.E. (See
Group VII.)

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 DIPLOMA OF HONOUR, *International Fisheries Exhibition, 1883*
 BY APPOINTMENT to the *International Health Exhibition, 1884*

Number of House Clocks made 15,550.
 „ of Church and Turret Clocks made 920.

FOR EXHIBITS SEE COMPLIMENTARY LIST (page xlii)

MOORE'S PATENT IMPROVED GLASS LOUVRE VENTILATORS



FOR
 PUBLIC AND PRIVATE BUILDINGS GENERALLY.

Are made to any size, and can be fitted to every description of Wooden or Metal Sashes, and are finished in the best manner.

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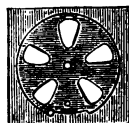
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MOORE'S Improved Circular and Sliding Glass Ventilators.



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PAPER, PRINTING, BOOKBINDING, STATIONERY, &c.

BY DR. HUGO MÜLLER, F.R.S., &c.

PAPER.—But little has been added to the already highly-perfected mechanical processes paper-making. Some minor improvements in the rag-engine, knotters, glazing, finishing, and printing machinery are all that need be mentioned. The advances during the period represented by the present Exhibition lie almost entirely in the direction of a vastly increased production, which has enlarged, to a corresponding extent, the range of raw materials from which the manufacture of paper draws its supplies.

Twenty-five years ago the consumption of paper was already so vastly on the increase that it became more and more evident that the ordinary sources of paper material could not satisfy the demand, and that before long a very serious increase in the price of paper must be the consequence unless new sources could be found. Great strides have been made in this direction, and although a material has not been found which can entirely replace the rags, abundant supplies of several materials have become available which at all events serve to meet the increased demand. Researches and experiments in this direction were by no means neglected, and numerous substances have been proposed in the course of time as new paper materials. Unfortunately, in many instances, these proposals were made without due regard to the quantity and quality of the fibre contained in the raw materials, and the subsequent trials on a manufacturing scale only too often resulted in utter failure. We will content ourselves with mentioning those which have come into actual use.

Some of the earliest experiments were made with straw, and although various kinds of paper were made from this material for a considerable time, it was only within the last thirty years that paper of a better class made from straw could be obtained. But straw has by no means been found either a cheap material or one which is easily converted into paper-stuff, and at the present time it appears that the manufacture of straw paper is, if anything, on the decrease. A much more important material is esparto or halfa, which was introduced by Routledge, and finally, after a great struggle, was established as the most perfect amongst the substitutes for rags. This material is remarkable for the ease with which it furnishes a clean and white fibre. Moreover, it possesses a peculiar property which renders it particularly suitable for the manufacture of fine printing papers. Esparto was at first almost entirely imported from Spain, and later on from the North Coast of Africa, where it is met with from Morocco to Tripolis; but, unfortunately, its growth is extremely slow, and attempts to raise it by regular cultivation have to the present been only partially successful. It is reported that it takes from twelve to fifteen years for young plants to mature sufficiently to yield useful leaves. On account of its toughness it can only be collected by pulling off the leaves from the stalks, a process very destructive to the plants. For this and other reasons the supply of esparto has of late not materially increased, and if other countries besides England were to find it to their advantage to import this material, the limited extent of its production would very soon become apparent. It is estimated that the quantity of esparto imported into England amounts to 180,000 tons, and as it is reckoned that good esparto yields close upon 50 per cent. of paper fibre, 90,000 tons of paper are thus derived from this source alone.

Similar to the esparto are the leaves of the dwarf-palm *Chamaerops humilis*, which likewise grows to a considerable extent in some districts of the South of Spain and the North Coast of Africa. This material is capable of furnishing an excellent fibre for paper, but, for some reason or other, it has never become of any very great importance. In America, leaves of similar kinds of palm, which grow in the Southern States, have likewise been used for making paper. Reeds and bamboos also furnish good materials, and it is a well-known fact that the Chinese make some kind of paper of excellent quality entirely from green bamboo. Both these materials have been made use of to a considerable extent in the United States.

It has been repeatedly proposed to employ the refuse of the sugar-cane, so-called Bagasse, as paper material, but this contains so little of true fibre that it is not surprising that these attempts

have completely failed. The same applies to the proposed utilisation of hop-bine. Various kinds of barks (bast) have been frequently used, and, indeed, the famous Japanese paper, which is remarkable for its toughness and the varieties of forms in which it is employed, is entirely made of the bark of the paper-mulberry and some species of daphne. That the strength of the Japanese papers is mainly due to the length of fibre has been demonstrated by attempts which have been made to work up imported half-stuff from Japan on the paper-machine. The necessary reduction of the fibre in the rag-engine completely changed the character of the paper thus produced, which indeed exhibited none of the remarkable qualities of the Japanese papers which are made by hand.

There is one particular kind of bast, viz. that of the *Adansonia digitata*, which is used occasionally in England for making paper of an extraordinary strength. Another important accession to the paper materials is jute in the form of gunny-bags, jute-cuttings, and butts. These materials are used to a considerable extent for strong papers, and especially for making the so-called Manila paper, which formerly used to be made entirely from old Manila ropes.

For some time past experiments have been made with a view to converting wood into paper, and about twenty-five years ago Voelter, following in the footsteps of Keller, succeeded, by dint of untiring perseverance, in perfecting the process of disintegrating wood by mechanical means. This process consists simply in grinding green wood, principally that of conifers, on a grindstone in presence of water. This invention was eagerly taken up in countries where wood abounded and where cheap water-power was available. Enormous quantities of this wood fibre are now produced in Norway, Sweden, Germany, and the United States; and according to the degree of care bestowed upon the operation and the efficiency of the machinery, a paper material is thus produced which either by itself or, still better, in combination with rag-stuff or other strong fibre, furnishes a paper perfectly suitable for cheap newspapers, cardboards, and similar purposes. The extensive use of this ground wood is often severely criticised; but it has to be borne in mind that its application has set free a corresponding amount of rag-stuff, and it is due to this circumstance that, notwithstanding the enormous increase in the consumption of paper, the dearth of rags has not been felt. Some modifications in the machinery have been introduced in America, consisting mainly in the substitution of emery wheels or circular steel rasps for the grindstone. A development of this process in another direction consists in submitting the wood, previous to grinding, to the action of steam under pressure, whereby the coherence of the wood is materially lessened and the disintegration much facilitated. Although the fibre thus produced is of a light brownish colour, it is rendered much more supple and is much longer. It is therefore particularly suitable for packing papers and paper-hangings, and is generally used without any other admixture.

Whilst in the foregoing processes the defibration is effected by mechanical means, other and equally important methods have been introduced in which the same end is attained by chemical agencies. By this action both the intercellular substance, which binds together the individual cells of the wood, and the lignine which makes them rigid, are removed, and thus the cellulose is obtained in an isolated form. Although the product obtained by this chemical operation is small, amounting to not more than 50 per cent. of the dry wood, it is far superior to the wood pulp obtained by the mechanical processes, and in fact, if not equal to rag pulp, it is nearly as good as esparto fibre. Moreover, it can be perfectly bleached. The first process introduced by Watt and Burgess, and first carried out by them in America, consists in the treatment of chipped wood with a solution of caustic soda of a moderate strength under high pressure. Although simple in principle, a good many difficulties had to be overcome before it became practicable. However, within the last fifteen years a great many factories have been erected for working it, and large quantities of cellulose have been thus made available.

In 1866 Tilghman took out a patent for treating wood with sulphurous acid or acid-sulphites, for the purpose of converting it into paper pulp. This process, however, seems never to have been carried out on a large scale by the inventor, and, in fact, had been altogether forgotten when Mitscherlich, some ten years later, rediscovered and patented the same process. According to Mitscherlich, the wood in a suitable form is treated with a strong solution of bi-sulphite of lime under pressure as about 150° C., whereby, as in the previously described alkaline process, the intercellular substance and the lignose are removed and the cellulose is set free. Eckmann, in Sweden, instead of bi-sulphite of lime, uses the corresponding magnesia salt. Quite recently another modification of the same process, patented by Pictet, and which is about to be

introduced, consists in the treatment of wood with concentrated sulphurous acid in closed vessels; at 80° to 90° C., and at the corresponding pressure of four to five atmospheres. The cellulose obtained by these sulphurous acid processes is much tougher than that obtained by the alkaline treatment, and as, moreover, these processes are more economical, it may be confidently expected that before long the greater part of the wood cellulose will be produced by this way.

It appears from recent observations that paper made from chemically prepared cellulose does not maintain its pristine strength, but is liable to become brittle and less tough—a change apparently due to an alteration in the cellulose itself and not, as might be supposed, to any of the chemical agents remaining in the pulp.

Willesden Waterproof Paper.—The Willesden waterproofing process, which consists in the application of Schweitzer's solution of cellulose in ammoniacal oxide of copper, has also been very successfully employed for paper, which thereby is rendered suitable for many uses.

PRINTING.—It is a noteworthy fact that in its essential points the art of printing attained almost at the time of its introduction a degree of technical perfection which has hardly since been surpassed. Some of the earliest specimens still extant of books printed by Gutenberg, his associates and their numerous pioneers, who in the second half of the fifteenth century spread their new invention throughout Europe, are equal to the best work produced in modern times. Indeed it may be said that during the next three centuries the art remained almost stationary, the intellectual and social conditions of the time making small demands on its progress, and the printing craft, like all others, being hampered and restricted by rigid traditional trade customs.

In recording the progress made in printing during the last twenty-five years, it is to be remarked that it has been almost entirely confined to the attainment of the greatest possible speed in production, and it may, moreover, be said that this has been mainly effected by the further development of the principles involved in the printing machines previously in use. It seems therefore appropriate, in reviewing these modern improvements, to point out this continuity in their progress, and to take a retrospective glance at the short period in which machine printing took its rise, and which preceded the epoch represented by the present Exhibition.

Towards the end of the last century, with the impetus given to the advancement of the industrial arts by the introduction of the steam-engine, and the development of mechanical engineering generally, a new era began also for printing, which is marked by Earl Stanhope's invention of his link and lever printing press, the first made in iron. Modified by others and improved upon, this press became the type of machines which are in use at the present day, either as hand presses or in a much larger form as the so-called platen machines worked by steam or other power, and which are still considered by many to be the most efficient presses when the highest degree of perfection in printing is desired. Whilst, however, this form of press still retains the original principle of applying a flat plane moving parallel to itself and to the type form, a new system had already been suggested by Nicholson in a patent dated April 29th, 1790, wherein he described various ways of making use of the surface of rotating cylinders instead of the flat plane of the platen. He proposed to pass a table containing the type between an upper and a lower cylinder, the former carrying the paper, and by means of cog-wheels or straps to act upon the table so as to draw it backwards and forwards, when set in motion, the inking being at the same time effected by cylindrical rollers which passed over the type as the tables moved to and fro. In another arrangement he suggested imposing the type, which for this purpose was to be tapering, on one cylinder, whilst the paper was held and pressed against the type by a second cylinder, both moving at the same speed. In a third arrangement a pressing cylinder holding the paper was to be rigidly united and geared into a rack on a long table on which the type was placed, and thus the printing was to be effected whilst the table moved to and fro.

Although Nicholson's patent comprised all the important elements of our present printing machine, such as rotating cylinders, cylindric inking rollers and distributors, grippers, &c., it was not turned to any practical account, and fully twenty years elapsed before printing by machinery became a reality. The merit of having constructed the first printing machine is due to Frederick König, who, having occupied himself for a number of years with the improvements of the printing press, came to London in 1807, and here, with the pecuniary support he received from Messrs. Benaley and Taylor, and with the assistance of the gifted mechanical engineer Bauer, he was enabled to continue those experimental trials which finally led to success. His first machine, constructed and

patented in 1810, was a platen, which, however, having served to demonstrate the possibility of printing by machinery, was abandoned for another scheme worked out and patented in 1811. The second machine became the prototype of the single cylinder press now in use. The description of this patent reveals incidentally the great difficulty which presented itself when attempts were made to apply the only means then in use for inking the type to the quick moving printing machine, and in these days it requires some effort to realize and appreciate this formidable obstacle.

The treacle and glue composition roller, one of the most important acquisitions of the printer, was only invented two years later by Bacon and Donkin.

By this time the interest of Mr. Walter, the proprietor of the *Times*, had been enlisted in these inventions, and all efforts were now concentrated upon the construction of the famous printing press, to which allusion is made in the columns of the *Times* of Dec. 29th, 1814. The press printed about 1100 copies per hour.

This achievement served as an incitement to others, and in quick succession a number of able engineers devoted themselves to the further development of printing machinery. The König's machine was soon supplanted by one constructed by Applegath and Cowper, which turned out as many as 10,000 copies of the *Times* per hour. In its turn this machine was superseded by one of Hoe, called the type-revolving fast printing machine, made with two more impression cylinders. A gigantic machine was made upon this principle for the *Times* by Whitworth, and was put in operation in July, 1859. It had ten impression rollers, and required ten men to feed in the paper, and produced 18,000 copies per hour. In the same year a machine was made by Applegath for the *Standard* with five impression rollers placed horizontally. In Hoe's machine, but two men were required to feed in the paper at each impression roller, which arrangement the machine could print 20,000 copies per hour. Marvellous, however, these results may be considered, the requirements of the daily newspapers were a constant stimulus to greater exertions, and once more the engineering workshop of the *Times* printing office was given up to the further development of high speed printing machinery.

The experience which had by this time been gained by means of these huge printing machines, was now applied to the further development of rotary printing in a new direction, finally resulting in the construction of a machine which prints both sides of a continuous newspaper. This is called the Walter press, and its action may be described as follows: the paper is fed from a reel (containing about 4 miles in length and weighing 6 cwt.) into a series of four cylinders, the two last of which are covered with flannel or felt and kept damp. It is passed between the first and second of four cylinders raised perpendicularly above each other, the top one being covered with the stereotype casts from the first four pages of type and the bottom one with the casts of the remaining four pages. In passing thus between the first and second cylinder the paper receives the impression on one side. It then passes backwards between the second and third cylinders, and resuming its forward direction in passing between the third and fourth receives the impression of the four remaining pages on the other side.

After receiving the first impression, the paper is led between two highly polished rollers, one of which acts as the set-off, and being kept clean by a special wiping arrangement, takes the superfluous ink, thus preventing the print from being blurred in its onward course. It then passes then between two cylinders where, by an ingenious contrivance, it is cut into sheets, and the sheets are at the same time counted. Finally the sheets pass through a folding machine, and leave the press. This printing press is served by two attendants, and prints 12,000 sheets per hour.

The speed of the large presses of the old construction was governed by the dexterity of the layer-on, and as for all practical purposes he could not feed in more than about thirty sheets per minute, the power of printing large numbers could only be increased by multiplying the impression-cylinders and proportionately enlarging the circumference of the type-bearing cylinders, whereby the machine became objectionably complicated and cumbersome.

Having regard to the special purpose for which it was designed, viz., the printing of newspapers at a great speed, we have in the Walter press arrived at a degree of perfection which for the present cannot probably be surpassed. Considered as a specimen of mechanical engineering, a simpler construction is hardly conceivable, whilst as regards the quality of printing, the attainment of a still greater speed would probably be incompatible with conditions which make efficient inking and fair impression possible. In looking back upon the intermediate steps which have led to this result, we can easily perceive that it required the co-operation of many important factors to bring it about. Apart from the skill in mechanical

engineering which is brought to bear in the construction of the Walter press, its completion is in great measure due to the high perfection to which the stereotyping process had gradually been carried in the *Times* office.

The introduction of the Walter press has been followed by the construction of several varieties of high-speed news-printing presses, such as the Bullock, the new Hoe, Campbell, Marinoni, &c., which more or less resemble their prototype.

In Lithography a very notable progress has also to be recorded by the general introduction and application of the principle of the cylinder printing press. The great difficulty which the popularities of lithographic printing once presented has been completely overcome, one of the latest improvements being the introduction of an arrangement by which the cylinder is arrested and the stone allowed to return and have the inking repeated before the impression is taken, thus affording the means of a more efficient inking of broad surfaces. The attempt made by Maurice to apply in lithography the use of cylindric instead of flat stones, with a view to printing an endless web-paper, does not appear to have fulfilled the high expectations which were entertained when it was first brought out, though it produced 7000 copies per hour, and the work was said to be equal to the best machine lithography. Lithography has of late years come much more extensively into use, especially for colour printing, and as there is still only the one original source for the supply of the lithographic stone, many attempts have been made to find an artificial substitute for it, but without any marked result. Quite recently, however, this desideratum seems to have been attained by an invention which may be considered an improved zincographic process. It is stated that it consists in covering a suitably prepared zinc plate with a thin film of calcareous substance whereby a surface is obtained possessing all the remarkable properties of the lithographic stone.

The principle of the cylinder machine has been also very successfully applied to the construction of presses which print two or more colours whilst a sheet of paper is passing through the machine. Of these, the two-colour machine, introduced about twenty years ago by Loenig & Bauer (the successors of the original inventors), is ingenious and perfect in its action. More than other machines have been constructed in this and other countries for printing even more than two colours, but being very complicated and only applicable in special cases, they have not come much into use.

To the Americans we are indebted for the introduction of the now well-known jobbing printing machines worked by a treadle.

The type-setting machine has been simplified and perfected, and its use has become much more general; on the other hand, the distributing machines with which we are acquainted so far have not yet attained a satisfactory degree of efficiency. The automatic type-casting and finishing machines have so materially reduced the cost of type that it almost competes with the cost of re-distribution.

The invention of soft and elastic type, or indiarubber stereotyping (Leighton's Patent, 1864), has proved a most useful means of applying printing in a novel form, as it affords especial advantages in the decoration and stamping of hard and unyielding substances, such as glass bottles, metallic surfaces, and also for hand-stamps.

The great progress in Photography has also been brought to bear upon printing, especially in the direct production of printing plates and blocks. There are now several processes in use which effect this in a very perfect manner. They depend upon the well-known action of light upon bi-chromated gelatine, and are in fact developments of Photogalvanography, Phototypy, and Woodbury-type.

BOOKBINDING.—The advances to be recorded in bookbinding refer almost entirely to the introduction of labour-saving machinery, which in a variety of ways is made use of, especially in the production of the cheap class of cloth cover-binding. By means of these appliances, bookbinding is now done on a vast scale and in a very short time. It not unfrequently happens that a thousand or more volumes of a new and popular book are bound in less than twenty-four hours to meet the exigencies of the book trade.

On the other hand, the higher class of bookbinding has to all appearance reached or even passed the climax of perfection; and binding of a quality to delight the bibliophile is now to be obtained only with difficulty, and probably before long may become altogether extinct. Much of this decline in the quality of workmanship is to be regretted, another danger has become

manifest in recent times; that is, the liability of the leather to perish, especially on the backs of books. This has been ascribed to the supposed inferior processes of dyeing and preparing the leather; it can, however, be readily proved that the leather binding of old books which stood well for ages is rendered equally perishable under special circumstances. The true cause of this destruction is the sulphur contained in the coal used for heating and lighting, which is ultimately converted into sulphuric acid. Its action upon the leather is therefore especially noticeable in libraries where gas is burned. Morocco leather appears to resist better than Russia and calf. India-rubber binding, which was in use for some time, and which consisted in cutting the book into single leaves and backing them with a layer of indiarubber cement instead of stitching, has fortunately nearly disappeared. This binding was very liable to fail, and many valuable books have been ruined by it.

A noteworthy addition to the bookbinding materials has been made by the introduction of what may be called leather-paper, or vegetable leather. Some of them, as, for instance, the leatherette and artcorium, are in appearance very much like the cheaper leather and are quite as tenacious.

The following are some of the more important bookbinders' machinery introduced into general use during the last twenty-five years.

Folding Machines are found to be extremely useful in enabling binders to have large quantities of periodicals folded and issued at a very short notice. Some of the more recent machines fold bookwork very satisfactorily, but in no case is this work equal to handwork, because the sheets are folded by registering from the print on one side only.

Sewing Machines.—By means of these machines, large numbers of a work can be sewed up in a short space of time. Nearly all the machines use wire instead of thread; consequently books sewed in this manner seldom open so well as when sewed with the latter, and the wires are liable to cut through the folds. There is also a stiffness about the sections which prevents the backing of the books being so well executed as when sewed with thread. Machine stitching is, however, an improvement on the former method of stabbing and stitching through the sheets themselves.

Sawing Machines are of quite modern introduction. Formerly the books to be sewed on cord by hand had to be previously grooved with a handsaw for receiving the cords. This work is now evenly and satisfactorily performed by the sawing machine.

Backing Machines are now used for all classes of binding except the very best. For the best leather-binding they are unsuited, in consequence of the great force necessary to cause the sections to overlap each other. The books are often rendered unsightly inside by bad backing, causing wrinkles down the centre of the sections.

Trimming Machines.—Formerly all books not cut by the plough had to have the rough edges cut away by means of a long hand-knife and straight edge, a process which was both slow and tedious. This is now done by the trimming machine.

Bevelling Machines.—When thick bevelled boards are required, this machine is used to assist in chamfering off the edges of the boards.

Book Rounding Machines have been much used of late years instead of hammering the book round by hand, and they perform this work very quickly.

Steam-Blocking and Inking Machines.—Steam-blocking machines have been in use nearly thirty years, but steam-inking machines are much more modern. On account of the cost of production, the present method of ornamenting book covers with several coloured inks in combination with gold would hardly have come into general use but for their introduction.

GROUP XXVI.—PAPER, PRINTING, BOOKBINDING, STATIONERY, &c.

EAST GALLERY.

[For Applications of Photography to Printing, see also Group XXIX.]

1973. PROPRIETORS OF THE 'GRAPHIC' NEWSPAPER (THE), 190 Strand, London, W.C.—Improvements in printing machinery. Also the various pro-

cesses illustrating the whole method of producing a high-class Illustrated Newspaper Machinery in Motion, &c.

1974. INGRAM, WILLIAM JAMES, 'ILLUSTRATED LONDON NEWS,' 193 Strand, London, W.C.—Four-colour Rotary Machine.

1975. DALDY, F. R., 294 City Road, London, E.C.—(1) Smyth's Thread Book Sewing Machine, which sews at the rate of 18,000 sheets per day, either on tape or cord. (2) Smyth's Book Sawing Machine, adapted to the above.

1976. VIRTUE, J. S., & CO., Limited, 294 City Road, London, E.C.—(1) Copper-plate Printing Press at work on Etchings for the 'Art Journal.' (2) Specimens of Etchings, Line Engravings and Reproductions from the 'Art Journal.'

1977. NEWSUM, WOOD, & DYSON, Charnmouth Street, Beeston Road, Leeds.—Anglo-American Litho Machine.

1978. HENDERSON, RAIT, & SPALDING, 3-5 Marylebone Lane, London, W.—(1) Music Punches, Matrixes and Rules from the Scheurman process; also blocks and rules of the Cowper. (2) Engraved and Stamped Copper Plates of Music, Portraits of Musicians, &c. (3) Lithographic Printing Machine, with taking-off apparatus, by Messrs. Hughes and Kimber.

1979. CROSLAND, WILLIAM, New Street, Miles Platting, Manchester.—Machinery for making paper box: (1) The Advance Self-clamp Paper Cutting Machine. (2) Roller Scoring Machine. (3) Millboard Cutting Machine. (4) Cornering Machine. (5) Card Cutting Machine.

1980. FURNIVAL & CO., Reddish Iron Works; and 7 Charterhouse Street, Holborn Circus, London, E.C.—(1) Demy Improved Wharfedale Printing Machine, for book and job printing. (2) Crown Folio Godfrey's Patent Gripper Platen Printing Machine, for general job printing. (3) Foolscap Folio Patent Caxton Platen Printing Machine, for general job printing. (4) 26-in. Gill's Patent Hot or Cold Rolling Machine, for glazing and finishing plain and printed paper. (5) 32-in. Furnival's Patent Express Self-clamp Guillotine, for cutting books, paper, millboard, &c. (6) 20-in. Furnival's Patent Express Guillotine, for general paper cutting.

1981. GODFREY, ALFRED, 23 Wellington Terrace, North Reddish, near Stockport.—Improved Self-delivering, Self-registering Platen Printing Machine.

1982. SALMON, JAMES, Blackfriars Bridge, Manchester, W.—(1) Double Crown Wharfedale Printing Machine, with Salmon, Smith, & Co.'s Patent Taking-off Apparatus, and Salmon's Patent Web Feeding Attachment. (2) Demy Lithographic Printing Machine, with Salmon, Smith, & Co.'s Patent Taking-off Apparatus. (3) Salmon's Patent Victory Self-clamp Guillotine Cutting Machine. (4) Salmon's Patent Wire Stitching Machine, for the corners of paper, cardboard, and wood boxes.

1983. HORNE, W. C., 5a Aldermanbury Postern, London, E.C.—(1) Improvements in the manufacture of luminous paper. (2) Patent Duplex Folding Paper Machine. (3) Martini's Patent Duplex Folding Paper Machine, as used by Messrs. Clowes & Sons for folding this Official Catalogue. (4) Thompson's Patent Wire-stitching Machine,

as used for stitching the Official Guides of this Exhibition. (5) Huber's Patent Engraving Machine, for hatching work.

1984. AYLING, JOSEPH JAMES, 4 Crane Court, Fleet Street, London, E.C.—Improved Apparatus for preparing drawing or transfer paper which, being photographed or lithographed upon a zinc plate, produces illustrations for use with type; the whole process of making the blocks being shown daily, from the artist's drawing to a complete block.

1985. SPRAGUE & CO., 22 Martin's Lane, Cannon Street, London, E.C.—Ink-Photo Process by steam power and photolithography.

1986. NEWALL, HENRY, & SON, 10 Marsden Street, Manchester.—(1) Mechanical and Chemical Wood Pulps. (2) Wood Flour, &c., used in the manufacture of paper, linoleums, and other fabrics.

1987. GREENWOOD & BATLEY, Albion Works, Leeds.—Patent Continuous Web Platten Printing Press, crown size.

1988. LITHO PLATE CO. (care of O. & E. LAYTON, 56 Farrington Street, London, E.C.)—Patent Litho Plates. A substitute for lithographic stone. Also a patent bed or foundation for securing and stretching the plates when being printed from in existing machines.

1989. SLADE BROTHERS, 169 Great Portland Street, London, W.—(1) Patent Self-binding Cover for periodicals, music, newspapers, &c. (2) Portfolios on stands. (3) New Letter Files. (4) Music Folios.

1990. BRUCE, W. P., Kinleith, Currie, Midlothian, N.B.—Dark Ground Etching.

1991. COLLEY, WALTER WILLIAM, 253 Camberwell New Road, London, S.E.—Model of Double-web Printing Machine.

1992. YOUNG, T. GRAHAM, Durris, Aberdeen.—Preparation of Wood Pulp.

1993. RICHARDSON, KOOLMAN, & ISGER, Raquet Foundry, St. Bride Street, London, E.C.—(1) Fine Art Moulding Composition, for electro deposition for letterpress, steel, and copper plates. (2) Patent Curved Electrodes for rotary machines. (3) Specimens of Electrodes for Lanham's Patent Lace Printing. Exhibition Medals. (4) Mosaic and other Tiles, &c., &c.

1994. RUBBER STAMP CO. (THE) 15 Holborn Viaduct, London, E.C.—Stereotyping in Rubber by the dry process.

1996. JAMESON, JOHN, Akenside Hill, Newcastle-upon-Tyne.—Improved Safety Paper. Delible designs, fugitive and washable prints, and transformation pictures. Available for protection against forgery, and as

security for postage and other stamps, for transformations in advertisements, and for birthday and Christmas cards, &c.

1997. **AITCHISON, C.**, Loanhead Foundry, Midlothian.—Patent Rag Engine, with conical roll and improved bottom plate.

1998. **INGLEFIELD, COL. G. H. S.**, Millbrook, Parsonstown; King's Co., Ireland.—Patent Appliances to Artists' Palettes, by which method colours can be removed from the palette, and replaced in the shortest possible time, preserving their original freshness.

2000. **EDWARDS, F. A.**, 621 High Holborn, London, W.C.—Patent Combination Note Paper and Envelope. Suitable for letters, memorandums, bill-heads, invoices, circulars, statements, &c.

2001. **BAREOW, SAMUEL, & CO.**, Stakehill Works, Castleton, Manchester.—Patent Combined Book Cloth.

2002. **COHEN, A. & E.**, 47 Basinghall Street, London, E.C.—Hammonia Type Writer.

2003. **CROPPER & CO.**, 28 Budge Row, Cannon Street, London, E.C.—(1) American Patent Folding Paper Box. (2) Patent Folding Wood Box for parcels post, &c.

2004. **RIDDELL, W. M.**, Westham Road, Forest Hill, London, S.E.—(1) Manufacture of paper, paper boards, waterproof paper, and other articles of a fibrous texture from waste bark. (2) Tan Extract and a manure from the refuse material.

2005. **STUART & CO.**, 8 Thomas Street, Edinburgh.—Granolithographic Printing Stones.

2006. **COOKE, G. K.**, Mfg. Co., 74 & 75 Cow Cross Street, London, E.C.—(1) Patent Apparatus for manufacturing rubber stereotypes, type, and printing faces. (2) Presses and Appliances for using same.

2007. **ENGLISH & FOREIGN ELECTROTYPING AGENCY**, 19 to 23 Ludgate Hill, London, E.C.—The Universal Copier [Steuer's Patents], for obtaining an unlimited number of copies in printer's ink on any material and in exact facsimile of any MS. or printed matter, such as circulars, drawings, engravings, music, &c.

2008. **BAWCOMBE, HENRY**, 21 Victoria Road, Holloway Road, London, N.—Improved Letter Clips.

2009. **DAVISON, C. E.**, 7 Nevill Road, London, S.W.—(1) Letter File. (2) Fare and Ticket Indicator.

2018. **MACNIVEN & CAMERON**, 23 to 33 Blair Street, Edinburgh.—(1) Waverley, Pickwick, Owl, Hindoo and other Improved Steel Pens. (2) Patent Yielding Penholders.

2011. **WRIGHTSON, WILLIAM**, Beech Street, Barnsley, Yorkshire.—Improvements in manifold copying books.

2012. **APPLETON, EDWARD**, Brecknock Crescent, Camden Road, London, N.W.—(1) Patent Non-blotting Double Ruler. (2) Self-inking Ruler. (3) Interest Calculator and Short Cuts for Mental Calculation.

2013. **ANDREW, F. W.**, 3 Netley Terrace, South Kensington, London, S.W.—(1) The South Kensington Seat, for the use of artists, serving also as easel. (2) Drawing Board and Table, adapted for the use of female as well as male students.

2014. **WOOD, MISS, ELMWOOD**, 389 Enham.—Adjustable Geometrical Ruler, combining T square, set square, protractor, beam compass, with a new invention for drawing circles in colour and an angle meter.

2015. **MEISENBACH CO.**, Limited, 31 Farringdon Street, London, E.C.—(1) Blocks for printing with letterpress; suitable for illustrating books, journals, magazines, &c.; produced direct from photographs, paintings, wash drawings, and pen-and-ink sketches. (2) Specimens from Meisenbach Blocks.

2016. **PAVITT, THOMAS, & CO.**, Southampton Row, London, W.C.—(1) Patent Paint and Varnish Sash Tool and Glue Brushes. (2) Artists' Brushes, Pencils and Enamel Bronzer.

2017. **BAYLING & TAYLOR**, 8 Carterbury Street, Hill Fields, Coventry.—Apparatus of Instrument for painting of mental lines on carriages, house decorations, hardware, &c.

2018. **JONES, CHARLES ALLAN**, Hatherley Court, near Gloucester.—(1) Improvements in easels of stands. (2) The Hatherley Easel.

2019. **HALL, JOSEPH**, Wharfedale Chambers, Sheffield.—(1) Improved Case for the use of accountants and auditors. (2) Improved Case or Receptacle to facilitate collection of moneys.

2020. **FAIRHOLME & CO.**, 22 Fleet Lane, Fleet Street, London, E.C.—Cyclostyle, an apparatus for reproducing similar copies of writings, drawings, plans, &c. in black and coloured inks.

2021. **DE BUNSEN, MISS VICTORIA**, 41 George Street, Portico Square, London, W.—The Postage Stamp Apparatus, for stamping and affixing postage stamps on envelopes.

2022. **UMPHREYSTON & CO.**, Limited, Engineers, Leith.—Patent Rag Engine for paper pulp. This engine is fitted with a beater, but breakers or poachers are made of similar construction.

2022. DALLAS, D. C., 12 Crane Court, Fleet Street, London, E.C.—(1) Dallas-type and Dallastint Photo-graving, Chromo-Dallastint, Litho and Zineo-Dallastint. (2) Hyalotype or Glass Engraving, for printing and other purposes (Crocker's Patent). (3) Autoglyphy [Dallas' Patent], for engraving metals without etching by acids or other solutions—an application of Crocker's Patented Hot-pen.

2024. MANN, GEORGE, & CO., Island Road, Leeds.—(1) Climax Lithographic Printing Machine, with taking-off apparatus, and damping arrangements. (2) Climax Hand Press, This machinery is worked by Clement Smith & Co., Strand, W.C.

2025. HARRILD & SONS, Fleet Works, 25 Farringdon Street, London, E.C.—(1) Printers' Rollers and Roller Composition. (2) Fine Art Two-feeder Illustrated London News' Registered Bremner Machine. (3) Franco-Bremner Fine Art Cylinder Press. (4) Chromo-Litho Bremner Machine. (5) Registered Bremner Machine. (6) Fine Art Bremner Platten. (7) Treadle Bremner Platten. (8) Stereotype Foundry, Core Bars, Adjustable Gauges, and Metal Furniture Moulds. (9) Printers' Joinery and Utensils.

2026. WATERLOO & SONS, Limited, 25, 26, & 27 Great Winchester Street, London, E.C.—(1) Blocks for printing from, produced by various photographic processes. (2) Woodburytype Printing Process. (3) Presses for printing same. (4) Ticket Printing Machine. (5) Ticket Counting Machine. (6) Examples of Engraving on steel and copper.

2028. FELT, W. O., 55 & 56 Chancery Lane, London, W.C.—Shading Mediums, for slipping, graining, lining, &c., on stone, zinc, and other flat surfaces.

2029. DAY & COLLINS, Limited, Atlas Works, Farn Street, London, E.C.—(1) Vahra's Patent for machine-cut wood type. (2) Type Cases. (3) Poster Block-cutting by machinery. (4) Inventions in Printers' Joinery.

2030. POLYCHROMATIC SIMULTANEOUS PRINTING CO., Limited (THE), 153 Queen Victoria Street, London, E.C.—Improvements in printing in colours on textile or other fabrics, and in the apparatus employed therein.

2031. BREHMER, AUGUSTUS, & 4 Moor Lane, Fore Street, London, E.C.—Machines for sewing books with wire and thread.

2032. WILLARD, WILLIAM, 80 London Street, Reading.—The Reading Printing Machine.

2033. TITCHENER, OLIVER, 3 Wilmington Street, Clerkenwell, London, W.C.—Improvements in casting hollow moulds and quotations.

2034. HONEYWOOD, THOMAS, Courtney House, The Causeway, Hordham.—Improvements in Nature Printing, applied to pottery, wall papering, fabrics of every description, microscopic objects, &c.

2035. GILLOTT, JOSEPH, & SONS, Victoria Works, Graham Street, Birmingham.—Specimens illustrating sixteen separate processes of the manufacture of steel pens.

2036. WILKINS, TWISDEN, 3 Meredith Street, Clerkenwell, London, E.C.—Improved Portable and Adjustable Frame Tent.

2037. BREMAN & ROBERTS, 6 King Street, Cheapside, London, E.C.—Remington Standard Type Writer.

2038. HOOK, WILLIAM HENRY, Fairholme, Elsie Road, East Dulwich, London, S.E.—The Simplex Envelope Folding Machine, for steam-power or treadle, having movable boxes for folding envelopes of various sizes and shapes by same machine.

2039. LAWRENCE BROTHERS, 48 Farringdon Street, and 57 Shoe Lane, London, E.C.—(1) Gally's American Universal Printing Press. (2) Berlin & Jones's Patent American Leader Envelope Gumming and Folding Machine. (3) Cradison's Patent Undeaf Self-clamp Paper Cutting Machine. (4) Royle's Patent Routing Machine. (5) Richard's Patent Ruling Machine for wood engravers.

2040. COPYING APPARATUS CO., Limited (THE), 88 Farringdon Street, London, E.C.—(1) Lellin's Patent Autocopyist. (2) Wilson's Patent Hektograph, Chromograph, Simplex Printer, and Hektograph Sheets. (3) The Albert Patent Type Writer and duplicating process. (4) The Cyclostyle. (5) Medicated Sanitary Paper, with patent bracket with automatic cutting action.

2041. FRASER, ALEXANDER (care of NEILL & CO., Government Printers, Edinburgh).—Type Composing and Distributing Machines.

2042. LYLE, JAMES, & CO., 57 Bishopsgate Street Within, London, E.C.—(1) Manifold Folding Newspaper Rack. (2) Bookshelves and Tables.

2043. THOMPSON & NORRIS MANUFACTURING CO., Limited, Arlington Street Works, Islington, London, N.—Improvements in the manufacture of corrugated paper as a packing material and parcels post wrapping.

2044. GREEN, G. F., & CO., 3 George's Yard, Lombard Street, London, E.C.—Wood Pulp, Boards, and Wood Papers.

2045. COHEN, B. S., 24 Great Prescot Street, London, E.C.—Pencil Sharpeners.

2046. **SKLIROS, G. E.**, 82 Mortimer Street, Cavendish Square, London, W.—Improvement in Newspapers, by which the preservation of a portion thereof in the form of a book or magazine is facilitated, and can be preserved and bound up separately into a volume.

2047. **MORNINGTON, E. W.**, 7 Charing Cross Chambers, Duke Street, Adelphi, London, W.C.—Improved method of indexing books.

2048. **GOVER, HENRY CHARLES**, Beechwood, Claremont Road, Highgate, London, N.—Patent Secretary Press, for india-rubber and other stamps.

2049. **PAPER CUTTING & REELING CO.**, 4 Coleman Street Buildings, Moorgate Street, London, E.C.—(1) Endless Paper Coils for Wheatstone, Morse, Hughes and other instruments. (2) Organette Music Paper. (3) Relief Stamping Paper. (4) Coils for French cartridges and cigarette machines. Tramcar and other tickets printed both sides, numbered and perforated.

2051. **CLAYSON, JOHN HENRY**, 20 Gellatly Road, Nunhead, London, S.E.—Improved Combination Grooved Stereo-Blocks and Sliding Catches for mounting stereo and electro plates for printing therefrom.

2052. **OSBORN & SHEARMAN**, Paulton Works, 334 King's Road, Chelsea, London, S.W.—Improvements in paper-hanging printing machines.

2053. **HILLS, ARTHUR**, Nonsuch Place, Cheam, Surrey.—Improved Drawing Board for fixing and stretching paper and other material for water-colour painting, &c.

2054. **RUBINSTEIN, A.**, 5 John Street, Bedford Row, London, W.C.—A Reversible or Multiplex Type, in which the characters are so formed that each type serves for two or more purposes, printing different letters according to the position in which it is placed in the composing stick.

2055. **BROWNE, NEWNHAM**, 73 Cheapside, London, E.C.—A Collection of Books, Forms, Specimens of Drawings, &c., illustrative of the method and cost of applying for and obtaining British Colonial and Foreign Patents, Registration of Trade Marks and Designs; and of the working of the various Patent Acts; also a set of Indexes to recent patents.

2056. **JOHNSON, CHARLES, & CO.**, 31 to 39 Vine Street, Clerkenwell Road, London, E.C.—Chromatic Printing on japanned iron plates.

2057. **ANDERTON & CO.**, 87 Norfolk Street, Sheffield.—(1) Stylo J Pens. (2) Electric Ink Pencils.

2058. **WRIGHT, E.**, 103 Ivanhoe Road, London, S.E.—Model of Type Writer;

also applicable to production of stereo-matrices or equivalents, each line of type being set before an impression is taken.

2059. **NEWTON, WILSON, & CO**, 102 Southampton Row, London, W.C.—(1) The Horograph, or Clock-work Pen. (2) The Wilson Stylus, or Stylographic Instrument.

2060. **LEONARDT, D., & CO.**, Universal Pen Works, 100 Charlotte Street, Birmingham.—Semi-circular Pointed Pens.

2061. **ZUCCATO & WOLFF**, 15 Charterhouse Street, Holborn Viaduct, London, E.C.—The Trypograph and the Papyrograph Apparatus, for producing large numbers of copies of writings, drawings, &c., in permanent black or any colour.

2062. **BEHRENS, EMIL**, Tottenham, London, N.—Improvements in portable copying presses.

2063. **PIPER, HERBERT**, 23 Howley Place, Maida Vale, London, W.—Patent Safety Envelope.

2064. **HANCOCK, C.**, 3a Ennensdale Road, Hither Green, Lewisham, London, S.E.—Blocks, Drawings, Prints, and Etchings on glass, &c.

2065. **RAFTER, HENRY**, 1 Kingswood Place, Dacre Park, Lee, Kent.—Improvements in obtaining relief printing surfaces.

2066. **BROOKE, EDWARD**, 1 Wey Avenue, Walthamstow, Essex.—Brooke Ground for painting upon in oil or water colours.

2067. **ARUNDEL SOCIETY (THE)**, 2 Old Bond Street, London, W.—High Art Chromolithographic reproductions.—(1) The Poets on Mount Parnassus, after the fresco by Raffaele in the Vatican. (2) The Transfiguration, the fresco by Dra Angelico at Florence. (3) The Adoration of the Saviour, after the fresco by Perugino at Perugia. (4) Pity, Justice, Theology, and Philosophy, after the frescoes by Raffaele in the Vatican. (5) Four Saints, after the frescoes by B. Montegna at Verona. (6) The Virgin Child, after the picture by Giorgione at Castelfranco. (7) The Salvation, after the picture by Albertinelli at Florence. (8) The Monument of Count Castellarbo at Verona. (9) The Interior of the Piccolomini Library at Siena. (10) The Monument of Cau grande della Scala at Verona. (11) The Virgin Child, after the picture by Holbein at Darmstadt.

AVERY, W. & T., Digbeth, Birmingham; and 14, 15 & 16 Cow Cross Street, London, E.C. (See Group XI, Queen's Gate Annex.)

BUCK & WOOTTON, 126 Westminster Bridge Road, London, S.E. (See Group XV.)

CAMERON, AMBERG, & CO., 27

Little Britain, London, E.C. (*See Group XXII.*)

FOULIS, J., 28 Market Place, Musselburgh, Midlothian, N.B. (*See Group XI.*)

JAMES, T., 32 Great George Street, Liverpool. (*See Group XXIX.*)

KIRKALDY, JOHN, 40 West India Dock Road, London, E. (*See Group IV.*)

KITE, JAMES, & CO., Phoenix Iron Works, Vauxhall, London, S.E. (*See Group XI.*)

LAND, EDWARD, 2 Laurence Lane, London, E.C. (*See Group III.*)

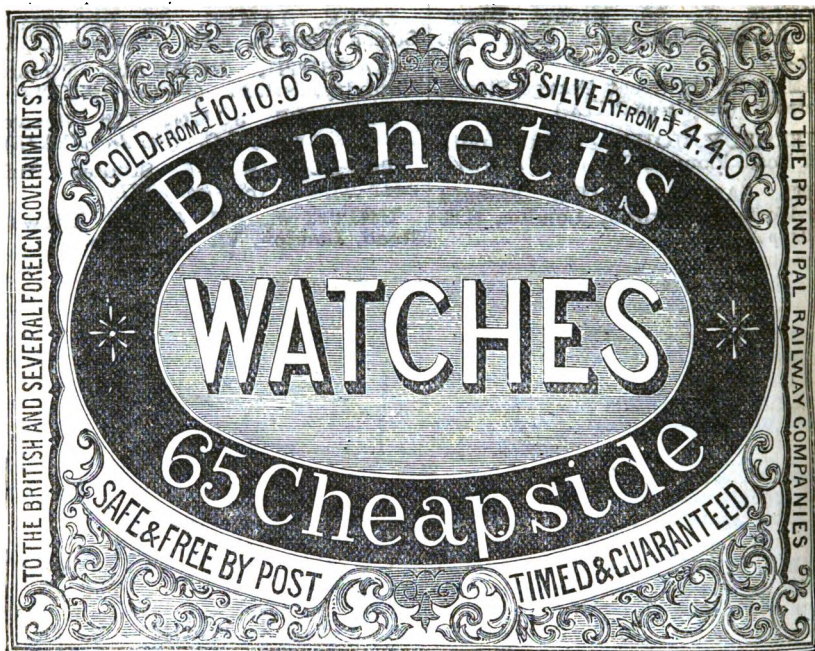
LYLE, JAMES, 57 Bishopsgate Street, London, E.C. (*See Group XXII.*)

MACBETH, NORMAN, Victoria Foundry, Bolton. (*See Group XXIX.*)

MASTERS, JOHN, 175 Goswell Road, London, E.C. (*See Group XXII.*)

TAYLOR, W. W., Studley Park, near Ripon. (*See Group XII.*)

UNITE, J., 291 & 293 Edgware Road, London, W. (*See Group I.*)



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SIR JOHN BENNETT offers the small remainder of his choice and valuable Stock of GOLD and SILVER KEY WATCHES at 20 PER CENT. REDUCTION, as he intends to keep none but Keyless Watches.—Cheapside, E.C.

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WATCHES and CLOCKS, with the double circle showing the old and new style from the same hands.

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£10.—In return for a £10 Note, free and safe per post, one of BENNETT'S LADY'S GOLD KEYLESS WATCHES. Perfect for time, beauty, and workmanship, with keyless action; air, damp, and dust tight. Gold chains at manufacturers' prices.—65 and 64, Cheapside.

£15.—In return for Post Office Order, free and safe by post, one of BENNETT'S GENTLEMEN'S GOLD KEYLESS LEVER WATCHES, with chronometer balance, and jewelled in 13 actions. In all respects a thoroughly sound, useful watch. SIR JOHN BENNETT, Cheapside, E.C.

£20.—For MEDICAL, SCIENTIFIC, and RACING MEN.—Sir JOHN BENNETT'S HANDSOME GOLD KEYLESS LEVER CENTRE SECONDS STOP WATCH, with chronometer balance, and jewelled in 13 actions. Perfect for time and durability.

CLOCKS.—The FINEST STOCK in LONDON. At prices lower than ever. Sir JOHN BENNETT, Watch, Clock, and Jewellery Manufacturer, 65 and 64, Cheapside London, E.C. Catalogues post free.

CLOCKS, WATCHES, AND OTHER TIMEKEEPERS.

BY EDWARD RIGG, ESQ., M.A.

The inventions comprised in this group are, if we may judge from the almost universal use that is made of them, fairly entitled to a considerable share of public interest. The use of timekeepers has very rapidly extended with their reduction in price during recent years, but it is no less true that the horologists' art has latterly received even less encouragement than it received in the past. This neglect has deprived the public of a fascinating study, and the progress of the art has been proportionately retarded, while many of the purely scientific points involved have at the same time been lost sight of. The general reduction in prices, while increasing the number of timekeepers in use, has had an unfortunate effect on the highest branches of the art since workmen are led to occupy themselves mainly on the cheaper qualities, which, though involving less skill, are on the whole more remunerative.

A glance at the literature of the subject affords evidence, and perhaps also some explanation, of the indifference with which it is treated by the public. Since the publication of the last edition of Reid's 'Treatise on Clock and Watch Making,' in 1843, no original work has been published in the English language until the present year, with the exception of Sir E. Beckett's well-known and justly esteemed manual. These, however, are mainly devoted to the consideration of clocks, and it says much for the individual skill and intelligence of the English watch and chronometer makers, that their art should have attained such eminence as it has in this country without possessing a single treatise that could pretend to being fairly complete. Within the past few months, however, a prominent member of their craft has come forward and done much to fill up this gap, and the manual on 'Watch and Clock Making,' by Mr. Glasgow, may be almost considered the first work on this subject from the pen of an English maker. The 'Horological Journal' has done good work in calling forth original articles connected with the trade, many of which are of the highest value; for the rest we can only quote such works as those of Harrison, Mudge, and Earnshaw, mainly descriptive of their own special inventions, and scientific investigations by Sir G. B. Airy, Bloxam, Sir E. Beckett, and others, which have materially improved our theoretical understanding of escapements, compensation, and such matters.

The Continent has long possessed an extensive horological literature, comprising such treatises as those of Thout, Berthoud, Lepaute, Dubois, and Moinet, and the more modern scientific and eminently practical works of Saunier, complete English translations of whose 'Treatise on Modern Horology' and 'Watchmakers' Handbook' have for some years occupied an important position in our technical literature. In recent years also elaborate investigations into the minute sources of error in the chronometer, and analogous subjects, have been published in France by Leduc, Villard, and others.

The general awakening in recent years to the conspicuous failure of the old apprenticeship system to cope with the demands of the present day in all branches of manufacture, and the consequent necessity for establishing some organised system of technical instruction, which have helped to call forth the above works and others of a like nature, may be confidently expected to do much towards resuscitating at least the watch-making branch of horology in the near future; already the City and Guilds of London Institute for the Advancement of Technical Instruction has been instrumental in establishing an organised system of theoretical and practical instruction in various centres of the industry; and signs are not wanting, even in the present depressed state of trade, that the English watch and clock trades are in some respects in an improved condition. The advance which has taken place in the Swiss watch-making trade during the eight years that have elapsed since the Philadelphia International Exhibition in 1876 presents a very remarkable instance of such a revival, and one which may well lead us to hope for the future of English manufactures. The Swiss delegate to that Exhibition, M. Favre-Perret, presented an elaborate Report, setting forth the advances made in America in the production of watches by

machinery. Although exception was taken at the time to this report as being exaggerated, the Swiss were led to reconsider and to largely reorganise their system of manufacture; and the figures given below, whilst showing the gradual falling off of their exports to the United States up to the period of that Exhibition, doubtless in the main owing to the increasing competition of the home produce, exhibit an astonishing increase since the changed conditions under which the trade had to be carried on have been more fully recognised.

Year.	Value of Swiss Exports to the United States.	Year.	Value of Swiss Exports to the United States.
	Francs.		Francs.
1870	16,512,172	1877	3,569,948
1871	17,105,752	1878	3,995,716
1872	18,812,511	1879	5,292,098
1873	13,054,147	1880	10,143,813
1874	12,119,941	1881	11,809,122
1875	8,499,501	1882	13,238,489
1876	4,809,822	1883	11,146,010

These most significant figures may safely be relied upon as at least approximately accurate. They are given both in a report by the American Consul at Zurich, in reporting to his Government on the recent Exhibition held in that town, and by the Swiss Vice-Consul at New York, who further emphasises their importance by adding that whereas the exports were formerly of finished watches, those of the present day consist mainly of "movements" which are fitted into cases made in America, and must, therefore, be far more numerous, to reach so high a total value. Seeing that so great a revolution has been inaugurated in Switzerland, largely in consequence of a report on the Exhibition held in 1876, is it too much to hope that the Exhibition now being held in London, the centre of the English watch-making industry, may do much to arouse English manufacturers from the lethargy into which many of them have fallen, and induce them to adopt such modifications in their system as experience shows to tend towards the production of a cheaper, more artistic, and not less accurate timekeeper than they at present provide? It should be understood that we are here only considering the average quality of watch; in the highest grades foreign competitors have not beaten us either in accuracy of adjustment, soundness of workmanship, or reasonableness of price.

In the year 1870 the total population of Switzerland actually engaged in watch-making and its branches, is given as 37,969; and in 1883 it was estimated at about 5000 more. The last three English Censuses show the number of persons returned as watch and clock makers to have been:—

	Men.	Women.	Total.
1861	20,221	536	20,757
1871	20,693	580	21,273
1881	22,576	775	23,351

There thus appears to be a steady though slight advance in the numbers, and in England the trade affords occupation to rather more than half as many individuals as are similarly employed in Switzerland. Unfortunately we are not in a position to compare accurately the total out-turns in the two countries, since reliable statistics are not accessible; but the hall-marking returns show that about 190,000 watch cases are annually marked in England. Many of these cases are foreign, so the number of watches manufactured here is considerably under 200,000, or about nine for each person engaged in the trade. Switzerland is estimated to produce about 1,600,000 per annum, or no less than 40 per workman—a striking contrast, which helps to explain why the English watch is so much more expensive. It should be added, however, that the latter commands a higher average price, probably about double what is obtained for the former, and that a far larger proportion of the persons enumerated in the Census are exclusively engaged in sale, and in no sense makers, in England than in Switzerland: both these circumstances help to make the contrast less marked.

The figures comprised in the following table afford interesting information as to the state of

the trade at the three last Census periods, thus covering the ground to which the present Exhibition has special reference. In order to avoid as far as possible the influence of accidental circumstances, the figures in each column give, not the statistics for the Census year itself, but a mean of the returns for the five years nearest to that year. Thus, the figures in the first line are means of the returns for the five years 1859-1863 inclusive; in the second line for the years 1869-1873, and in the last line for the years 1879-1883, also inclusive.

Census. — England and Wales.	Total Imports.		Nett Imports.		Exports of Foreign Produce.	Exports of Home Produce.	
	Clocks.	Watches.	Clocks.	Watches.	Total.	Total.	Per Workman.
Watch and Clock Makers.	£	£	£	£	£	£	£
20,757	211,303	278,411	203,080	279,669	13,706	126,430	6·1
21,273	363,426	359,905	349,662	338,408	35,260	143,526	6·7
23,351	515,053	469,892	452,330	437,308	95,309	213,892	9·1

There is undoubted evidence in the above figures that the volume of trade has grown, but it is much to be feared that the improvement observable in the last two columns is in excess of actual facts, owing to the unfortunate practice which exists of manufacturing watches abroad in imitation of English, and selling them here as such, a practice which is facilitated by the freedom with which home-made and foreign watch cases are alike hall-marked in this country.

It is only at rare intervals that important changes occur in such an art as horology—an art which from the earliest times has possessed special claims to attention, and which had therefore attained a high development when other branches of mechanics were in their infancy. Rapid strides were made towards accurate time-keeping by the celebrated horologists of the latter part of the 17th and of the 18th centuries; mainly by Tompion, Graham, Hooke, Harrison, Mudge, Arnold, and Earnshaw, in this country; and by Huyghens, Sully, Berthoud, Le Roy, and others on the Continent. During the 19th century the progress of the art is to be found rather in a better proportioning of the parts, a more exact workmanship, and a more scientific knowledge of the laws by which time-keepers are governed. At the same time, and this seems to be an especial characteristic of the last quarter of a century, the systems of manufacture have undergone considerable modifications.

The progress made in the various branches of horology may be conveniently considered under the several classes of Group XXVII. As to the first of these, England can hardly be said to have a general trade in clocks, only certain special kinds—regulators, turret, chiming, and a few dial clocks—being manufactured in this country. The artistic French mantel-piece clocks, and those of a cheaper quality for general use from the United States and the Black Forest have steadily increased in popularity, so that the demands of Great Britain alone for them have increased about threefold during the 25 years under consideration. The essentially English manufactures may, however, claim to have held their own, though the volume of trade done in them is comparatively insignificant; indeed distinct improvements have been introduced into these necessarily expensive branches of clock-making. As instances of these advances, we may refer to the remarkable standard sidereal clock at Greenwich, the real timekeeper of the country since it determines the distribution of the daily time signals, which was set up in 1871; the more complete use of machinery in the manufacture of turret and other clocks by our principal makers, who seem to be recognising that it is after all akin to other branches of engineering; and various improvements in the details of construction.

The use of time signals in this country dates from the year 1833, when the practice of letting a large ball fall punctually at 1 o'clock in the day was first introduced at Greenwich Observatory, a practice which has since been uninterruptedly maintained. It was not, however, till 1852 that telegraphic time signals were distributed, the Astronomer-Royal providing the signal and the Electric and International Telegraph Company doing the work of distribution. Since the telegraph

were taken over by the Government in 1870, this work has devolved on the Post Office, Greenwich still providing the signal for it to distribute. The system has been much extended in recent years, since the Postal authorities undertake to supply time signals at a definite moderate charge to anyone desiring them. Side by side with this gradual extension in this country it is interesting to note the increased use that is made in various parts of the world of public time signals, established primarily for the use of seamen. According to returns prepared in the Hydrographic Department of the Admiralty, it appears that at the end of 1880 (the latest date for which statistics are accessible) such signals were made at 27 places in Great Britain, 24 places in British Possessions, and 42 places in foreign countries.

The public signals take various forms, such as a falling ball (the most common), collapsing cone, gun firing, semaphore dropped; and private signals are usually by electric bell or galvanometer deflection.

But in addition to the information thus distributed daily throughout the country on the direct authority of the Astronomer-Royal, various systems, introduced by private firms for synchronising clocks and otherwise extending the knowledge of exact time have recently come prominently into use. The electric currents may only pass at definite intervals, say once an hour, and mechanically adjust the clock hands to time, or may control the clock by passing at each beat of the pendulum of the standard clock, and thus maintaining all those in the circuit in unison with it.

In addition to electricity, air pressure has been made available for the distribution, as in the Popp-Resch system of pneumatic clocks, now extensively used in Paris; but, owing to the time occupied in transmitting the impulse depending on the distance (occasionally it occupies a minute), such a system is not comparable, as regards minute accuracy, with those involving the use of electricity. Both domestic and public clocks are controlled from a single centre on this system, the hands all advancing at intervals of a minute, as is the case in remontoire clocks.

Side by side with the several methods of control above indicated, a more extended use has been made of astronomical instruments for determining exact noon, as witness the dipteroscope, an ingenious device of the late Mr. J. M. Bloxam, and the popular forms of transit instrument.

In speaking of the distribution of time reference should be made to the discussion recently held, which has resulted in the adoption of the Greenwich civil day as the universal day throughout the world for all purposes for which it may be found convenient. Whilst the small extent of this country from east to west prevents us from appreciating fully the advantages of such a system, its importance to the astronomer and navigator is obviously great, and our commercial relations with foreign countries would derive benefit from its adoption. The device partially adopted in Canada and the United States of subdividing the countries of the world into districts determined by the hourly meridians east or west of Greenwich and taking the times as determined, which only differ from the universal time by integral hours, as the times of the several districts, would materially reduce the inconveniences, and thus tend to secure the general use of the system.

In Class 146—Watches and Chronometers—a comparison with the exhibits in the 1882 Exhibition should show marked changes both as regards the design and method of manufacture of watches. The changes in design are perhaps in the main owing to the general adoption of keyless in place of key-winding watches, a modification which in its turn has practically involved the abandonment of the fusee, so long characteristic of English work, in all but watches of the highest class. At the same time the full-plate movement has in great part already given place to the $\frac{1}{2}$ and $\frac{3}{4}$ -plate. These modifications have occurred concurrently with, if, indeed, they may not be regarded as a consequence of, the more general use of machinery, more or less automatic, for the manufacture of the various parts of watches, a radical step which has long afforded matter for energetic debate in all centres of the industry.

Although so marked an advance has been made during the period under consideration as might almost point to the use of machinery being a recent introduction, this is not the case. Early in the century several manufacturers in Switzerland and France employed it for special operations, but P. F. Ingold, a Swiss, was the first to design, about the year 1837, machines for both case and movement work which were capable of producing any number of identical pieces. After ineffectually endeavouring to establish his system in a complete form on the Continent, and actually establishing a factory in this country, which, however, proved financially

successful, he went to the United States in 1845, with a similar object in view, but only to experience further disappointment. Five years after, however, a small factory was established at Waltham in Massachusetts, and, so far as America is concerned, the factory system may be said to date from this period. After many vicissitudes this developed into the Waltham Watch Company, and thus to the Americans belongs the credit of having first brought the factory system into prominence for the production of completed machine-made watches. Hand-labour had long previously been superseded by machinery in Europe in the manufacture of numerous detached parts. Naturally the early years of an undertaking which deals with so vast an amount of work as the manufacture of watches involves, are spent in organisation, and in contending with difficulties as they arise. A further important circumstance tending to check the growth of such large factories is to be found in the fact that a large number of special and expensive tools are required for the many details, while the out-turn of one in a day may keep pace with that of other in a week. As illustrating the extent to which the work is subdivided, it may be mentioned that the movement alone, exclusive, that is, of the case, dial, hands, spring and balance, requires no less than 100 distinct machines.

While the more general use of machinery and other circumstances have contributed to materially reduce the cost of timekeepers, and distribute them through all classes of society, it is none the less true that the standard of time-keeping, both in chronometers and in watches of the higher class, has greatly improved. Evidence of this is afforded, in the case of the former, by the annual Greenwich chronometer trials. Unfortunately we have not hitherto been able to obtain similar evidence in regard to watches in this country, but both the English public and the manufacturers are to be congratulated on the fact that systematic trials of watches were established at Kew Observatory last year, so that any owner or maker of a high-class watch can now obtain an authoritative statement of its rate for a moderate fee. Such a certificate of time-keeping properties from an independent competent authority may be expected to serve both as a wholesome stimulus to makers and as a means of increasing the demand for the best workmanship. Similar trials have in many years past been held in Switzerland, and the results obtained afford indisputable evidence of progress in this respect.

A comparison of the exhibits comprised in the Class "Tools, &c.," may be expected to show marked contrasts to those in use twenty-five years ago. Although in all branches of horology, from turret clocks to watches, hand labour has been more and more replaced by machine tools, it is in the manufacture of the less expensive class of watches that the most marked changes have been brought about. To these reference has already been made. The appliances possess much interest as examples of high-class and exact machinery, but the experience of former exhibitions leads us to fear that a not altogether unnatural wish to prevent imitation will deter manufacturers from displaying their most perfect specimens.

Until within the past few years the small hand tools used by watchmakers and repairers had been gradually brought into a more and more unsatisfactory condition, mainly in consequence of the demand for cheaper qualities. Fortunately, however, a revival has set in and the higher classes now paid secure tools of both better quality and improved patterns. As examples of these, many novel appliances manufactured by Boley of Wurtemberg, for watch, clock, and telegraph instrument makers, deserve special mention. An important, though subsidiary, branch of the trade is that in what are known as "material" or the various detached pieces required in the manufacture and repair of timekeepers. This naturally follows the main trade both in its bulk and variations, and the influence of machine-manufacture shows itself in the number of pieces which are now obtainable finished and ready for use with little or no fitting.

Finally, we may look to much progress towards the general adoption of standard gauges and dies in all branches of the trade, a natural consequence of the manufacture by machinery; the absence of such a systematic series has done much to hamper the trade in the past, and its introduction should not longer be delayed; as a step in this direction it is much to be hoped that the standard series of small screws recently recommended by a Committee of the Mechanical Section of the British Association, and identical with that already adopted by the Society of Arts of Geneva, may ere long be in as general use as is the Whitworth system of screws for engineering work.

GROUP XXVII.—CLOCKS, WATCHES, AND OTHER TIME- KEEPERS.

(SOUTH CENTRAL GALLERY.)

[For Electrical Clocks, see also Group XIII.]

2084. FRODSHAM & CO., 31 Gracechurch Street, London, E.C.—(1) Chronometers. (2) Watches. (3) Clocks. (4) Marine and Pocket Chronometers. (5) Fusee and Going-barrel Keyless Watches in various stages of manufacture.

2085. BENSON, JAMES WILLIAM, 62 & 64 Ludgate Hill, London, E.C.—The Patent Dust and Damp Excluding Band for watches.

2086. GRIMSHAW & BAXTER, 33 & 35 Goswell Road, London, E.C.—(1) Clock and Watchmakers' Tools and Materials: Combined lathes, wheel-cutting engines for flat and keyless work; machine tools for jewel-setting, uprighting, fraising, and sinking, as used by manufacturers of watches on the interchangeable system. (2) Lathes and Mandrills, as used by telegraph instrument constructors.

2087. GOLDSMITHS AND SILVERSMITHS COMPANY (MANUFACTURING), 112 Regent Street, London, W. (Manufactories: Clerkenwell, Sheffield and Belfast).—Improvements in diamond cutting and polishing, and the manufacture of gem and gold jewellery, sterling silver and electro plate, watches and clocks.

2088. DENT, E., & CO., 61 Strand, London, W.C.—(1) Improved Ship's Compasses. (2) Uniform Pressure Clock. (3) Astronomical Clock with galvanic contact apparatus for dropping a time ball. (4) New Compensation Pendulum. (5) Small Galvanic Chronograph. (6) Chronometer with galvanic contact apparatus. (7) Watches with improved lever escapement. (8) Improved Small Turret Clock. (9) Detached Pieces of Machine-made Clock Work.

2089. BAILEY, W. H., & CO., Albion Works, Salford, Manchester.—Bailey's Improved Turret Clock.

2090. WYCHERLEY, HEWITT, & CO., Warrington Road and Scotch Lane, Prescot, Lancashire.—Watch Movements on the gauge and duplicate system, and complete set of Improved Watch Barrel-making Machinery.

2091. KEW COMMITTEE OF THE ROYAL SOCIETY (THE), The Kew Observatory, Richmond, Surrey.—Forms and Papers illustrating the methods employed at the Kew Observatory, Richmond, in examining, rating, and certifying as to the performance of watches, pocket chronometers and

chronographs for the manufacturers and general public.

2092. WALKER, JOHN, 77 Cornhill and 230 Regent Street, London, W.—(1) Railway Guards, Crystal Case, Aquatic Alarm, Repeating and Chronograph Watches and Chronometers. (2) Chiming and other Clocks.

2093. HASWELL & SONS, 49 Spencer Street, Clerkenwell, London, E.C.—(1) Improved Watch and Clock-Making Tools. (2) Watch and Chronometer Balance Springs in alloy of palladium. (3) Special Keyless Appliances. (4) Varieties in Watch and Chronometer Hands.

2094. ROWLEY, A. & H., 180 Gray's Inn Road, London, W.C.—(1) Large Chiming Clock with newly invented automatic figure work and perpetual calendar. (2) Clock with improved chiming on bells and gongs in newly designed Gothic oak case. (3) Lever Clock, striking the ship's bells, including the dog watch. (4) Parts of Clocks showing the stages of manufacture. (5) Various Chiming and other Clocks, with all the most modern improvements. (6) Two very Old Clocks with crown wheel escapements.

2095. SMITH, J., & SONS, 18 St. John's Square, Clerkenwell, London, E.C.—Improvements in Electric Time Bells, Chime and other Clocks.

2096. SAMPER, M., & CO., 80 Boulevard des Folies-Méricourt, Paris; and 1 Holborn Circus, London, E.C.—Patent Eight-day Alarms.

2097. DE GRUYTER CLOCK MANUFACTURING CO. (THE), 147a Aldersgate Street, London, E.C.—Warder's Patent Torsion Pendulum 400-day Clock; requires winding once a year.

2098. BENDON, GEO., & CO., 36 & 38 Ely Place, and 1 Charterhouse Street, London, E.C.—Keyless Clock.

2099. FIRTH, N. C., 125 Foregate Street, Chester.—Workmen's Patent Automatic Time-checking Clock.

2100. MILLAR, JOHN, Bethnal House, Cambridge Road, London, E.—Tall-tale Clock for Asylums, &c.

2101. LANGE, CHRISTIAN, 23 Great Portland Street, London, W.—(1) Winding Construction for keyless watches. (2) Gravity Escapement for church clocks and regulators. (3) Improvements in keyless and other watches, thereby dispensing with the bow and making it more convenient to wind.

2102. SOCIETY CHRONOS (MAYRHOFER & OTTO), 11 Abchurch Lane, London, E.C.—Anti-Electro-Hydro-Pneumatic Clocks.

2103. **SAGE, FREDERICK, 80-84** Gray's Inn Road, London, W.C.—Workmen's Time Check.

2104. **LEVY & LOWE, Hazeldean,** Knighton, Leicester.—Workmen's Time Recorder, for automatically registering the exact time of arrival and departure of operatives and others.

2105. **HANSON, L., & CO.,** Dean Clough Clock Works, Halifax—Patent Self-acting Timekeeper.

2107. **BRITISH HOROLOGICAL INSTITUTE (THE),** Northampton Square, London, E.C.—Contributions from Members of the Institute as follows:—

Bridgman, R., Poising and Other Tools.

Buckney, D., Fine Watches and Inter-changeable Parts.

Barnsdale, W., Various Types of Clocks.

Cousens, H., Patent Dials for 24-hour Clocks.

Corke Bros., Specimens of Watch-case Engraving.

Chalfont, W. W., Inventions connected with watchwork.

Donne, L., Fine Watches.

Greenwood, J., & Co., Machine-made Clock Movements.

Hammersley, J., Fine Watches and Watch Springs.

Harwood, G. H., Specimens of Watch-case Making.

Isaac, H. P., Watches and Chronometers.

Jackson, S., Anglemeter for lever escapements.

Mercer, T., Chronometer Clocks, Chronometers and Balance.

Mee, J., Model of Two-pin Escapement.

Nicole & Co., Watch Springs, Chronographs, &c.

Player, J., Improved Click for going-barrel ratchet.

Schoof, W. G., Chronometer, with 5-tooth lever escapement.

Tripplin, J., Models of Escapements and Trade Literature.

Wright, T. D., Anti-magnetic Watch.

Watchwork in various stages executed by Students of the Institute.

2108. **STANDARD TIME & TELEPHONE CO., Limited (THE),** 19 & 21 Queen Victoria Street, London, E.C.—(1) Standard Regulator. (2) Synchronised Clocks. (3) Clock fitted with contact springs to ring a series of electric bells at any stated times. (4) Hourly Flashing Signal.

2109. **WEBSTER, R. G.,** 5 Queen Victoria Street, London, E.C.—Improvements and inventions in clocks and watches.

2110. **MATHESON, J. S.,** Leith, N.B.—Keyless Chronometer.

2111. **ENGLISH WATCH CO., Limited (THE),** Villa Street, Birmingham.—(1) Improvements in design and construction of minute-recording Chronographs, Chrono-Micrometer. (2) Improvements in design and construction of railway guards' and other machine-made watches.

2112. **KENDAL & DENT, 106 Cheap-side, London, E.C.**—(1) Watches for the use of the Blind. (2) Watches with two separate dials, showing independently both the 12 o'clock and the 24 o'clock system of reckoning time with one movement only. (3) Watches showing the two systems of 12 and 24 o'clock on the same dial by the use of the elongated hour hand. (4) Watches with oxidized cases for the use of mariners and others. (5) Watches to measure distances by sound. (6) Chronometer Movement with Escapement in-Sight. (7) Lever Movement with Escapement in Sight. (8) Horizontal or Cylinder Movement with Escapement in sight. (9) Clock with triangle shape showing on two separate dials the two systems of 12 and 24 o'clock. (10) Clock with self-changing dial on the 24 o'clock system, obviating the necessity of having more than 12 figures on dial at one time.

2113. **HILLS, J. F.,** Post Office, Sudbury, Suffolk.—An English Keyless Lever Watch, with a specially designed dial, showing the code letters, for the use and convenience of postmasters and telegraphists.

2114. **HARRINGTON, J.,** Carmel House, Leamington.—Chime Clocks.

2115. **SQUIRE, R.,** 37 Myddelton Square, London, E.C.—(1) Dustproof and Waterproof Watches. (2) Improved Watch Movement, having [a] new isochronal hair-spring stud, [b] removable going barrel, [c] improved size of barrel to allow of an inappreciable variation in the force of the mainspring during 24 hours, and to reduce the risk of breakage of the spring.

2116. **MOORE, GEORGE, 35 Cressingham Road, Lewisham, Kent.**—Electric Alarm Attachment for clocks. The exhibit shows an eight-day mantel clock with the attachment on, and arranged with the switch, battery, and bell, connected up, showing an application of the patent in practical working order.

2117. **CAMERER, KUSS, & CO.,** 56 New Oxford Street, London, W.C.; Manufactory: 2 Broad Street, Bloomsbury, W.C.—(1) Chime, Watchman's Teltale. (2) Regulator Trumpeter. (3) Singing Bird. (4) Cuckoo Clocks, &c.

2118. **KULLBERG, VICTOR, 105 Liverpool Road, Islington, London, N.**—(1) Improvements in Marine Chronometers, viz.: Balances, Elastic Suspensions and

Galvanic Mechanism. (2) Improvements in Watches, construction of same, keyless mechanisms, &c. (3) Gas Governor for maintaining uniform temperature.

BARLOW, H. B., JUNR., & CO., Cornbrook Works, Manchester. (See Group X.)

CANNELL, CHARLES, Thorpe Asylum, Norwich. (See Group XIII.)

GRAY, E., & SON, 47 Clerkenwell Green, London, E.C. (See Group XIX.)

GRIMSHAW & BAXTER, 33, 35 Goswell Road, London, E.C. (See Group XIX.)

LEGÉ, A., & CO., 79 Turnmill Street, Clerkenwell, London, E.C. (See Group XXVIII.)

MITCHELL, E., Polytechnic Institute, 309 Regent Street, London, W. (See Group XXVIII.)

RICE, WILLIAM, 86 Fleet Street, London, E.C. (See Group XXX.)

TAYLOR, W. W., Studley Park, near Ripon. (See Group XII.)

THOMPSON, C. H. & C. W., 23 Mordant Street, Brixton, London, S.W. (See Group VII.)

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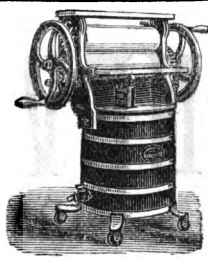


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PHILOSOPHICAL INSTRUMENTS AND APPARATUS.

By PROFESSOR G. CAREY FOSTER, M.A., F.R.S.

PHILOSOPHICAL Instruments are the tools of the experimental investigator. The instruments in use at each stage of the growth of science embody, in a concrete form, in their design and construction, the accumulated results of previous enquiry; and at the same time they indicate, by the purposes for which they are adapted, the directions in which further advance seems most practicable, and the methods by which it is hoped that advance may be effected.

The process of experimental research is made up of two chief parts. Stated generally, it may be said that a scientific experiment consists, first, in subjecting a portion of matter to well-defined conditions, or in causing some natural phenomenon to take place under definite conditions; and, secondly, in the accurate observation of the results.

Hence we may naturally divide scientific instruments into two main classes; namely, on the one hand, instruments for producing special physical conditions, or for the production of particular phenomena; and, on the other hand, instruments for defining these conditions or phenomena and for the observation of the resulting effects. To the former class belong, for example, pumps for causing rarefaction or condensation; arrangements for producing various kinds of motion, as of rotation or of vibration; means for the production of high or low temperatures; electric machines, voltaic batteries, dynamo-machines, or other contrivances for producing electric currents or differences of electric potential; magnets; sources of light, with lenses, mirrors, and instruments for polarising light. The latter class includes measuring instruments of all kinds, as, for example, chronometers, pressure-gauges, thermometers, electrometers, galvanometers, magnetometers, photometers, polarimeters; also standard magnitudes of every kind, as standards of mass, of length, and of volume; standards of electrical resistance, capacity, &c. To this class further belong such instruments as telescopes and microscopes, telephones and microphones, which may be regarded as exalting the powers of the senses, and also self-recording instruments of all sorts, whose function it is to replace, at least in part, the senses of the observer.

The purpose of the following pages is to indicate in general terms the most important changes that have taken place in the construction of philosophical instruments during the last quarter of a century or thereabouts. In accordance with what has been said above, it will be seen that this is equivalent to pointing out the directions in which the chief developments of experimental science, that have taken place within this period, have occurred.

On comparing the state of experimental science at the present time with its condition a quarter of a century ago, and especially when we compare the experimental appliances that are in use now with those that were commonly employed at that time, perhaps the most obvious change that is to be remarked is the increased prominence given in every department of research to numerical measurements, and the increased importance that is attached to carrying out such measurements with the greatest attainable accuracy. The recognition of the necessity for exact standards of measure for fundamental magnitudes has led to the establishment in Paris of the *Bureau international des poids et des mesures*. This bureau, to the expenses of which the Governments of nearly all civilised nations contribute, is rendering inestimable services to science by revising the primary constants of physics with every refinement of method and experimental means that the existing state of knowledge makes possible. This is work of a kind on which the progress of every branch of experimental science depends more or less directly.

In what follows it will be convenient to refer in succession to the main branches of science in which discoveries leading to the use of new experimental methods, or to the construction of novel classes of instruments, have been made. The references that can be made to particular matters are necessarily of the briefest possible kind; and, as a rule, no mention at all will be made of instruments that simply continue in use from former times, even though many of them may have undergone valuable modifications and improvements in some of their details. It need scarcely be said that anything like a complete enumeration of novelties is not attempted even in relation

to such subjects as are mentioned: all that is possible is a rapid indication of some salient points.

MATHEMATICAL INSTRUMENTS.—Various instruments for performing numerical calculations, such as improved forms of slide-rule, as well as more complex machines, have come into use within recent years. Some remarkable integrating contrivances have also been constructed, such as Professor James Thomson's disc, ball and cylinder integrator, Mr. C. V. Boys's integrator, and various developments to which it has given rise. Sir William Thomson's tide-calculating machine is also an instrument to be specially mentioned.

ASTRONOMY.—During the last twenty-five years the great improvement that has taken place in the manufacture of glass has rendered possible the construction of refracting telescopes of apertures formerly unheard of, such as the splendid 27-inch refractor constructed by Mr. Grubb for the Vienna Observatory, and the enormous glass (86 inches) now being worked for the Lick Observatory in California. Silvered glass has also largely superseded speculum metal for reflectors, the comparative ease with which glass can be worked making it possible to considerably reduce the proportion between length and diameter in telescopes with glass reflectors, and so to increase the power of moderate sized instruments. The application of the *spectroscope* in astronomy has thrown light on a multitude of problems which were previously thought to be beyond the range of possible examination, or which were not even known to exist, and has led to some of the most wonderful discoveries of the century. The progress of the art of *photography* has supplied a new method of astronomical observation, just as the progress of the manufacturing art of glass-making has led to improved means of carrying out the old methods. The rapidity of modern photographic processes promises to be of the utmost value as a means of obtaining records of exceptional or transitory astronomical events, such as eclipses and transits.

MOLECULAR PHYSICS.—In this department of science, the methods that have been devised for producing very high degrees of rarefaction in gases are perhaps the most important and fruitful among modern instrumental improvements. The mercurial air-pump, in one or other of the various forms that have been given to it by different inventors, has been an essential instrument in a large number of experimental researches. Among these, we may mention the experiments that led Mr. Crookes to the construction of the "Radiometer"; also the subsequent experiments of Hittorf, Crookes, and Goldstein upon the properties of highly rarefied gases; and several elaborate investigations into the passage of the electric discharge through gases at somewhat lower degrees of rarefaction than those specially studied by the physicists just named. It is likewise the mercurial air-pump that has made possible one of the most remarkable branches of modern industry—the manufacture of lamps in which the source of light is a filament of carbon kept in a state of incandescence by the passage of an electric current.

The experiments of Andrews on the continuity of the liquid and gaseous states ought also to be referred to in this connection, both on account of their own importance and because they have formed the starting-point of several other valuable investigations, including those of Pictet and Cailletet, into the liquefaction of what had till then been known as the "permanent gases."

ACOUSTICS.—Kundt's method of studying the velocity of sound by means of the dust-figures producible by the stationary vibrations of gases in glass tubes should be mentioned here, as having been found susceptible of many applications and having led to many important results. But the most remarkable experimental investigations in this branch of science during the last quarter of a century are undoubtedly those of Helmholtz, into the nature of musical "quality" and the causes of consonance and dissonance. Many methods have also come into use for studying and exhibiting the numerical relations of musical tones, among which the "vibration-microscope" of Lissajous, and the methods of MacLeod and Clarke, and Lord Rayleigh for the measurement of absolute pitch, may be specially mentioned.

The telephone and microphone, although belonging to Acoustics in respect of their effects, are electrical instruments in respect of the principles on which their action depends.

HEAT.—The range of explored temperatures has been extended of late years both upwards and downwards. By the evaporation of liquefied gases, temperatures nearly as low as -200°C .—that is, temperatures almost twice as far below that of melting ice as that of boiling water is above it—have been reached.

Among modern methods of studying the effects of heat, Fizeau's process for measuring the expansion of solids is one of the most remarkable, and has led to results of great importance.

The investigation, however, of most fundamental and far-reaching significance is that into the exact value of the mechanical equivalent of heat published by Joule in 1878 and confirmed in a remarkable degree by the almost simultaneous experiments of Rowland. The results of these experiments agree almost exactly with Joule's earlier determination of the same constant published in 1850.

OPTICS.—The methods of experimental research in optics during the last quarter of a century have been profoundly modified by the attention that has been given, since Kirchhoff and Bunsen's discoveries in 1859, to the study of the spectrum. The spectroscope has become one of the most important instruments, not only for purely optical investigations, but also in astronomy and in chemistry. In the earlier instruments, to obtain great dispersion a large number of glass prisms was employed, causing a great loss of light by absorption and repeated reflexions. Of late years diffraction-gratings, especially since the introduction of concave gratings by Professor Rowland, have come to be more and more employed instead of prisms when great dispersion is needed. This substitution is specially important in connection with the study of the kinds of radiation that lie outside the limits of the visible spectrum. Such radiation is often entirely intercepted by glass prisms. Recent advances in photography, principally in the hands of Captain Abney, R.E., have furnished an additional means of the greatest value for the study of invisible rays.

ELECTRICITY.—Among recent electrical discoveries, the methods of obtaining powerful electric currents by the application of mechanical motive power, and the use of these currents for purposes of illumination and transmission of power, have attracted far more public attention than all others. Inasmuch, however, as these discoveries have attained great industrial as well as scientific importance, they do not properly belong to this section of the Catalogue. Among the chief purely scientific advances in electricity which have led to the introduction of new instruments and experimental methods, we may mention specially the introduction of a coherent system of absolute measurement, resulting in the construction and wide-spread employment of accurately adjusted standards of various kinds. In this connection we cannot omit to mention the names of Sir William Thomson, the late Professor Clerk Maxwell, and Lord Rayleigh. A no less important step in advance has been the introduction of improved measuring instruments—electrometers and galvanometers—for which we are more indebted to Sir William Thomson than to any one else.

Another class of electrical instruments, whose practical importance dates also within the period we are considering, are electrical machines acting by induction, on the compound-interest principle, the earliest application of which seems to have been in Bennet's "Doubler" (1787). The application of this principle of action was revived by Varley in 1860, and has since been made familiar in the electrical machines of Töpler, Holtz, Voss, and Wilmshurst.

MAGNETISM.—But few new instruments have come into use in this branch of science. The continuous registration of the variations of the earth's magnetic force, and the study of terrestrial magnetism generally, has made considerable progress. The connection between magnetisation and conditions of mechanical strain have been studied by several investigators, especially by Wiedemann.

METEOROLOGY.—In this branch, even more than in magnetism, progress, as shown by the instruments employed, consists chiefly in the introduction of methods of continuous registration.

CHEMISTRY.—The spectroscope is undoubtedly the most important instrument that has been added to chemical laboratories in recent years. The Sprengel pump, various forms of temperature-regulators, instruments for gas-analysis, and for the determination of vapour-densities, and contrivances for facilitating fractional distillation, &c., have also come into common use.

PHYSIOLOGY.—The equipment of physiological laboratories has undergone very marked development and change of late years. Instead of relying almost exclusively on the microscope and a few chemical reagents, modern physiologists avail themselves very largely of physical appliances of the most various kinds. Instruments for the accurate measurement of time and the automatic registration of organic movements, with delicate electrometers and galvanometers, and apparatus for the application of graduated electric stimulus to nerve or muscle, are in daily use.

Conclusion.—Instruments and apparatus of various kinds are used in many other branches of science; but, for the most part, what has been said above as to chemical and physiological

instruments would apply: the instruments in use are physical instruments adapted for special purposes, and the progress that is marked by their employment lies, not in their construction, but in the recognition of their value as aids to special investigations. Thus the use of clinical thermometers marks an advance in methods of rational diagnosis, but is not of importance in connection with thermometry. Moreover, an attempt at indicating the recent changes in the instruments used in other branches of science would lead to the description of particular instruments and contrivances, the general principles on which all depend falling under one or other of the branches of physics.

GROUP XXVIII.—PHILOSOPHICAL INSTRUMENTS AND APPARATUS.

SOUTH CENTRAL GALLERY.

[For Testing Machinery, see Group III.; for Commercial Weighing Apparatus, see Group XI.; for Practical Applications of Electrical Apparatus, see Group XIII.; for Industrial Applications of Chemistry, see Group XIV.]

2125. ROSS & CO., 112 New Bond Street, London, W.—Microscopes, Telescopes, Photographic Lenses and Apparatus.

2126. BECK, R. & J., 68 Cornhill, London, E.C.—(1) Inventions and improvements in microscopes, microscopic apparatus, telescopes, photographic lenses and cameras, and other scientific instruments. (2) Ribbon-cutting Microtome. (3) New Microscope Lamp. (4) Electric Light for the microscope. (5) New Cheap Microscope. (6) New Portable Microscope. (7) High-power Object Glasses for the Binocular. (8) Large Binocular Telescope. (9) New Model Barometers.

2127. CROUCH, HENRY, 66 Barbican, London, E.C.—Microscopes.

2128. WIMSHURST, JAMES, 4 The Grove, Clapham Common, London, S.W.—(1) Large Electrical Influence Machine, plates 7 feet diameter. (2) Laboratory Influence Machine, plates 18 inches diameter. (3) Compound Continuous Electrophorus. (4) Parts of above machines. (5) Small Influence Machine.

2129. PICKARD & CURRY, 195 Great Portland Street, London, W.—Ophthalmic Appliances.

2130. LÉGÉ, A. & CO., 79 Turnmill Street, Clerkenwell, London, E.C.—(1) Tide-predicting Machines. (2) Combined Tide Gauge. (3) Self-registering Barometer. (4) Self-registering Anemometers. (5) Apparatus for measuring, recording, and registering depths of liquids. (6) Clock Movements, and the detached pieces thereof during the different stages of progress. (7) New Compensated Seconds Pendulum.

2131. CAMPBELL, SIR A. C., 2 Seamore Place, Mayfair, London, W.; and Blythswood, Renfrew.—Gerostat and Spectroscope.

2132. FROST, ALFRED J., 6 Westminster Chambers, London, S.W.—Transit Instruments, for obtaining time from the sun and stars, for popular use, without calculation of any kind.

2133. BAKER, CHARLES, 243 & 244 High Holborn, London, W.C.—Optical, Astronomical, Mathematical, Meteorological, Geographical, Nautical, and Biological Instruments, Microscopes, Improved Apparatus and Materials, Colorimeter, for determining the purity of water, Chorentoscope and Illuminated Compass.

2134. NEWTON & CO., 3 Fleet Street, London, E.C.—(1) New Patent Oxygen Microscope for projection. (2) New Patent Oxygen Micro-Polariscope for projection. (3) Patent Photographic Enlarging Lantern. (4) Portable Ruby Lamps. (5) Newton's V Section Sliding-leg Camera Stand.

2135. STEWARD, JAMES HENRY, 406 Strand, W.C.; and 54 Cornhill, London, E.C.—(1) Philosophical Instruments. (2) Dissolving View Apparatus.

2136. HARTLEY, PROFESSOR W. N., F.R.S., Royal College of Science, Dublin.—(1) Spectrograph for ultra-violet rays. (2) Portable Direct Vision Spectrometer.

2137. McHARDY, MALCOLM M. F.R.C.S., 5 Saville Row, London, W.—Self-registering Perimeter. This Perimeter registers on either of two scales. It is adapted for ascertaining and recording the fields of direct vision and of indirect vision; also for determining the angle of squint. It is adjustable to varying heights, and is both complete and durable.

2138. FINLAYSON, D., Minto House, Chambers Street, Edinburgh.—Combination Microtome.

2139. GARBETT, E. L., 8 Myddelton Square, London, E.C.—Improved Reflecting Circle for nautical use instead of sextant.

2140. HARLING, W. H., 40 Hatton Garden, London, E.C.; and Grosvenor Works, Hackney, London, E.—Improvements in mathematical, drawing, and surveying instruments.

2141. CAMBRIDGE SCIENTIFIC INSTRUMENT CO. (THE), St. Tibbs Row, Cambridge.—(1) Caldwell's Automatic Microtome. (2) Spectrophotometer. (3)

Sine and Tangent Galvanometer. (4) 14-inch Engineer's Level. (5) Rocking Microtome. (6) Water Motor. (7) Cathetometer.

2142. JOLY, J., 43 Pembroke Road, Dublin.—Apparatus for obtaining accurate readings of meteorological instruments placed at a distance from an observatory.

2143. BEILBY, GEORGE, Midcaldor, N.B.—Certain New Forms of Gas Thermometer, in which the gas is maintained at a constant pressure.

2144. GALLAND-MASON, ROBERT, Hambleton House, The Promenade, Douglas, Isle of Man.—(1) The Microphoscope. (2) The Detective Spectacles, enabling the wearer to see everything behind him as well as before him.

2145. DENTON, S. G., 25a Hatton Garden, London, E.C.—Unalterable Thermometers.

2146. DUDGEON, R. E., M.D., 53 Montague Square, London, W.—(1) Diving Spectacles, fitted with air lenses and glass lenses; an air lens free and an air lens immersed in glycerine to show refractive power. (2) Pocket Sphygmograph.

2147. LEDINGHAM, LAURENCE N., Murroughs Park, Govan, Glasgow.—Weight Voltmeter, for measuring electric currents.

2148. RIGG, JAMES, 11 Queen Victoria Street, London, E.C.—(1) Pair of Ellipses, to explain the mode of obtaining the pitched circles of tooth wheels. (2) Model of a conical toothed wheel and toothed cone to produce a rotation with varying velocity upon Roemer's principle. (3) Heart-shaped Cam in action between two friction rollers upon one oscillating bar, and producing equable motion in both directions. (4) Model, with a set of shifting slides and cams to explain and illustrate the different forms and actions of plane cams and tappets, and the principal kinds of motion which they are employed to produce. (5) Cam, arranged in the form of a groove on the face of a wheel to show how a law of varying velocity may be given to the end of a vibrating link or rod. (6) Boiler Punch, showing how, by a properly constructed cam, the greatest power of the machinery may be applied in the act of punching. (7) The principle of Calculating Machines, illustrated by a working model for addition and subtraction. (8) Folding Diagram in cardboard, to show the principle upon which guide pulleys are arranged to convey an endless band from one wheel to another when their axes are not parallel. (9) Model to illustrate the consequences of rotating the point of suspension of a cord passed round a single movable pulley. (10) Rod reciprocating by means of an eccentric pin and link, arranged so as to show the variations of its motion which arise from different lengths of links. (11) Combination of Hooke's joints in

iron, showing the effect of different inclinations of the axes. (12) Drop Box, to let fall simultaneously two large balls of cork and lead. (13) A Set of Apparatus to demonstrate and illustrate the construction, pressures, and tensions of the three legs, or triangle, shears, and derrick.

2149. MEEZE, ARTHUR G., Redhill, Surrey.—Improved means for measuring and continuously recording physical power. The apparatus consists primarily of a dynamical integrator for the meterage of quantities depending upon two variables. The chief forms of the instrument of practical value comprise—[a] A Transmission Ergometer, [b] An Electrical Energymeter, [c] A Meter for engine power, and [d] A Meter for water or other fluids.

2150. HARDING, ALFRED B., 1 Albion Villas, Catford, London, S.E.—(1) Harding's Magnetophone, for rendering audible the magnetic lines of force. (2) Edison's Phono-Motor, for talking a hole through a board. (3) Edison's Micro-tasimeter, for measuring very minute variations of temperature.

2151. SALOMONS, SIR DAVID, BART., Broomhill, Tunbridge Wells.—Philosophical Instruments.

2152. GROVES, WILLIAM, 89 Bolsover Street, London, W.—(1) Curve Writer, and Sets of Curves drawn by it. (2) Sonorous Vibration Apparatus. (3) Induction Balance and its accessories. (4) Magnetic Balance and Test Pieces. (5) Torsion Balance. (6) Sonometer. (7) Electrical Speed Indicator and Transmitter.

2153. BLAKESLEY, T. H., 25 Queen Anne's Gate, London, S.W.—Time Constant Measurer.

2154. TOWNSON & MERCER, 89 Bishopsgate Street Within, London, E.C.—Chemical and Philosophical Instruments and Apparatus and Balances.

2155. SMITH, F. J., Taunton.—(1) Ergometer or Work-measuring Apparatus. (2) Integrating Instruments. (3) Tricycle Ergometer.

2156. CUNYNGHAM, E. H., Hurlingham Lodge, Fulham, London, S.W.—(1) A Machine for describing rectangular hyperbolas for use in determining questions of maximum and minimum values in political economy and other sciences. (2) A Machine for solving logical syllogisms. (3) A Machine for solving by mechanical means the real and impossible roots of quadratic and cubic equations. (4) An Electric Meter and several Electric Integrators.

2157. HOW, J., & CO., 73 Farringdon Street, London, E.C.—(1) Apparatus for applying the heat test to dynamite, gun cotton, and similar explosives, with Dr. Dupré's improvements. (2) Apparatus for testing petro

leum so as to ascertain the temperature at which it gives off inflammable vapour. (3) Salinometers for ascertaining the amount of salt in the water of steam boilers. (4) Dr. Dupre's Apparatus for the estimation of urea by means of hypophosphite of sodium.

2158. GRIFFIN, JOHN J., & SONS, 22 Garrick Street, Covent Garden, London, W.C.—Biological Apparatus for the examination of micro-organisms, consisting of incubators, steaming apparatus, hot-air chamber, sterilising apparatus, cultivating vessels, filtration apparatus, apparatus for examination of air, &c.

2159. DEANE & CO., 46 King William Street, London, E.C.—(1) Fletcher's Patent Furnaces, for crucibles, tubes, muffles, ladles, &c. (2) Forges, Blowpipes, &c.

2160. HICKS, J. J., 8 Hatton Garden, London, E.C.—(1) Patent Clinical and Metallic Thermometers. (2) Patent Enamel Stem Hydrometers, Saccharometers, and Urinometers. (3) Clinometers and Prismatic Compasses. (4) Patent Range Finders. (5) Patent Depression Range Finders, invented by Major Watkin, R.A. (6) Patent Enamel Chemical and Medical Measures. (7) Patent Hyperdermic Syringes. (8) Patent Medical Lamps. (9) New Sunshine Recorder, invented by Professor McLeod. (10) Improved Anemoscope, invented by G. M. Whipple, B.Sc., F.R.M. (11) Improved Aneroid Barometers, and various other barometers. (12) Series of Standard Thermometers, with fixed zeroes that will not alter; heated by Hick's patent process. (13) Hick's One Minute Clinical Thermometer. (14) Hick's Patent Opaque Clinical and other Thermometers. (15) Beckley's Patent Self-Recording Ram Gauge by Hicks. (16) Large Thermometers, with lens front, the bore being magnified about twelve times. (17) Solar Radiation Thermometers in vacuo, with very minute bulbs, the bore being magnified about twelve times. (18) Patent Enamel Water Gauges for steam boilers, by Crossley, Hanson, and Hicks. (19) Frankland's Apparatus for gas and water analysis. (20) Anemometer as designed by Francis Galton, Esq. (21) An Assortment of Self-Recording Meteorological Instruments.

2161. EDWARDS, G., Whitby Lodge, New Thornton Heath, Surrey.—Improvements in callipers for measuring revolving objects, and in combinations of callipers, compasses, squares, rules, &c.

2162. TATE, S., 26 Gloucester Street, Clerkenwell, London, E.C.—Improvements in calculating machines or arithmometers.

2163. HEDICKE, M., & CO., 3 Adelaide Place, London Bridge, London, E.C.—Interest Calculating Machine.

2164. DIXON, T., Park View, Buttershaw, near Bradford.—(1) The Triple

Radius, Double Slide Rule and Mathematical Scale Tables of Lines and Cosines of Angles. (2) The Combined Circular Multi-stemmed, Logarithmic Decimals, Slide Rule equivalent to a straight one fifty feet long. (3) Machine for setting out and dividing spiral and circular slide rules, &c., and sundry examples of calculations, &c.

2165. HEATH, W., St. Stephen's Church, Westminster, London, S.W.—A Slide Rule for the conversion of time.

2166. WOLTERS, OTTO, 55 Upper Marylebone Street, Portland Place, London, W.—Improved Short-beamed Analytical Balances with weights.

2167. THORNWAITE, HORNE, & WOOD, 416 Strand, London, W.C.—(1) Photographer's Slide. (2) Optical Calculating and Exposure Calculating Rule. (3) Ackland's Astigmatic Disc. (4) American Photographic Lens and Camera. (5) Wood's Limelight Microscope. (6) Wood's Oxygen Jet and Oxycalcium Lamp. (7) The Lennox Browne Throat-Illuminator. (8) The Lennox Browne Gas Gauge.

2168. SHAW, PROF. H. S. HELM, University College, Bristol.—Various Applications of the Sphere and Roller Integrator: (1) A Polar Planimeter, acting upon the sine principle of calculation. (2) A Moment Integrator for giving, not only the area of a surface, but also its geometrical moment and moment of inertia. (3) An Integrator acting upon the tangent principle of calculation; the sphere being now supported by three rollers or disks, one imparting motion to it, a second determining its axis of rotation whilst the third records the product of the two variable quantities. (4) A Linear Planimeter acting upon the tangent principle. (5) A Cylinder Integrator acting upon the tangent principle. (6) Models for illustrating the action of the foregoing instruments.

2169. HARDING, T. R., & SON, Tower Works, Leeds.—(1) Improved Engine Machine and Pocket Counter. (2) Speed Indicator. (3) Improved Counter for gas and water meters. (4) British Standard Wire Gauge.

2170. EDMONDSON, JOSEPH, Heath Avenue, Halifax.—Circular Calculating Machine, for working the four fundamental rules of arithmetic.

2171. THOMSON, LIEUT. J. H., Bishopthorpe.—(1) Slide Rule for involution, evolution, compound interest, &c. (2) Calculating Disc. (3) Protractor. (4) Maquois Scales with variable angle.

2172. POLYTECHNIC SCHOOL OF PRACTICAL WATCH AND CLOCK MAKING.—(1) The Trinograph [J. Hermann's Patent], a tool for setting off angles and distances, applicable to watch manufacture.

turing on the interchangeable system. (2) The Graphical Quadrant, a tool for setting out the calibre of clocks and other instruments. (3) Specimens of work and tools for manufacturing watches on the interchangeable principle.

2173. **MULLER, J. A., C.E.**, Central Patent Offices, 6 St. Paul's Churchyard, London, E.C.—Improvements in anemometers.

2174. **LATHAM, B.**, 7 Westminster Chambers, London, S.W.—(1) Recording Rain Gauge. (2) Portable Tide Gauge.

2175. **STANLEY, W. F.**, 5 Great Turnstile, Holborn, London, W.C.—Various Inventions in mathematical, photographic, meteorological, microscopical, and scientific instruments.

2176. **ROSS, LIEUT.-COL. W. A.**, Acton House, Acton.—(1) Blowpipe Apparatus for the new system of anhydrous analysis called Pyrology, with a series of aluminium plates exhibiting the new coloured sublimes of gold and silver ores; and an aluminium furnace for quantitative analysis on the large scale. (2) Patent Condensing Smoke-filter Tobacco Pipe. (3) Original of the American Stylographic Pen.

2177. **ASTON & MANDER**, 25 Old Compton Street, London, W., for the late **GENERAL HANNYNGTON**.—Slide Rule.

2178. **IMMISCH, M.**, Electric Works, Ryland Road, Prince of Wales Road, London, N.W.—Metallic Thermometers for clinical and ordinary purposes.

2180. **KEW COMMITTEE OF THE ROYAL SOCIETY (THE)**, Kew Observatory, Richmond, Surrey.—(1) Photonephograph or Cloud Height Measuring Apparatus. (2) Apparatus employed in the examination and testing of sextants, quadrants, theodolites, &c. (3) Specimens of certificates awarded to instruments and general information relating thereto.

2181. **EVELYN, COL. G. P.**, 59 Wimpole Street, Cavendish Square, London, W.—Levels and Clinometers.

2182. **GLOVER, GEORGE, & CO.**, Royal Avenue, Chelsea, London, S.W.—Instruments of Precision for the measurement of gas, viz.:—(1) Unit of Measure for gas. (2) National Standard Gasholders. (3) Standard Dry Gas Meter, for resting meters in situ. (4) Pneumatometer, for measuring the capacity of the lungs.

2183. **ADIE, PATRICK**, Broadway Works, Westminster, London, S.W.—Astronomical and Surveying Instruments.

2184. **MASSEY, J. EDWARD.**, 17 Chadwell Street, Clerkenwell, London,

E.C.—Improvements in Ship Logs or machines for indicating the distance traversed by marine vessels, and ascertaining the depth of water or soundings.

2185. **YEATES & SON**, 2 Grafton Street, Dublin.—(1) Standard Metre. (2) Standard Yard. (3) Patented Standard Mercurial Pressure Gauge. (4) Electrical Rain Gauge. (5) Electrical Anemometer.

2186. **SILVERSIDES, J.**, 62 Duke Street, New Clee, Grimsby.—An Instrument for facilitating the calculations of Navigation. Specially applicable to the problems of Dead Reckoning. Independent of Nautical Tables.

2187. **BUCHANAN, J. Y.**, 10 Moray Place, Edinburgh.—Various Apparatus for deep sea investigation.

2188. **MOORE, F. M.**, 102 High Street, Belfast; and 23 Eden Quay, Dublin.—Improvement in the mariner's compass in iron and other ships, whereby the correctors are applied on true principles of position to keep their influence on the needles constant and equal in all safe angles of the ship, and to greatly reduce the Heeling Errors.

2189. **MEAGHER, R.**, 4 Brighton Terrace, New Cross Road, London, S.E.—The Polygon and Equatorial Improved Mariner's Compasses, with Code of Fog Signals.

2190. **HEATH & CO.**, 23 Fenchurch Street, London, E.C.—(1) Sextants. (2) Logs. (3) Compasses. (4) Sounding Machines. (5) Marine Glasses and Telescopes.

2191. **INGRAM, ROBERT**, Campbell's Patent Band Log Works, 11 Clerkenwell Close, London, E.C.—Patent Band Automatic Recording Speed, Direction, Distance.

2192. **LOWNER, R. M.**, Leicester House, East End, Finchley, London, N.—(1) The Patent Dollond Electric Ship's Log. (2) The Distance Indicator for bicycles and tricycles. (3) Portable Air Meters.

2193. **MELSHEIMER, R. E.**, 2 Plowden Buildings, Temple, London, E.C.—Lee-way Binnacle.

2194. **MAGINNIS, J. P.**, 23 Queen Anne's Gate, Westminster, London, S.W.—Instruments for Engineers and Draughtsmen: (1) Universal Sector. (2) Dead Beat Sectioners [various forms]. (3) Adjustable Parallel Ruler. (4) Ruling done with 3 and 4.

2195. **WILSON, W. J.**, F.C.S., 1 Colinton Villas, Ealing Dean, London, W.—(1) A Reflecting Tangent Galvanometer, indicating values of current upon an equally divided straight scale without calculation. (2) Harmonograph, or instrument for drawing curves produced by the composition of two rectangular vibrations.

2196. DE GRAVE, SHORT & CO., 59 St. Martin's-le-Grand, London, E.C.—(1) Improvements in balances similar to those supplied to Royal Mint. (2) Measures of Length. (3) Conical Standard Measures of Capacity. (4) Metric Weights. (5) Chondrometers. (6) Personal Weighing and Measuring Machines.

2197. OERTLING, L., Turnmill Street, London, E.C.—Assay and Bullion Balances.

2198. WELLS, SAMUEL, Osborne Park Gardens, Potter's Bar, London, N.—Self-calculating Square or Alimeter. An invention for measuring the height of trees, buildings, hills, width of a river, &c.

2199. RICHARDSON, B. W., 25 Manchester Square, London, W.—Apparatus for the painless extinction of life of the lower animals.

2200. LOVETT, E., Bank of Scotland, 43 Lothbury, London, E.C.—A Process for the preliminary preparation and permanent preservation of the most delicate organisms for microscopical investigation.

2201. WARD, P., 2 Holcroft Terrace, High Street, Fulham, London, S.W.—An Improved Apparatus for illuminating internal parts of the human or animal body for the use of surgeons, &c.

2202. HOBY, J. CHARLES J., '29 South Street, Thorloe Square, London, S.W.—Complete Set of Apparatus for use in collecting all kinds of geological specimens.

2103. ALLEN, JAMES, & SON, 21 & 23 Marylebone Lane, Oxford Street, London, W.—A Set of Apparatus as supplied to the Biological Laboratory of the Health Exhibition, and other apparatus for biological purposes.

2204. PHYSICAL SOCIETY OF LONDON, South Kensington.—Exhibits shown by the Members of the Society.

2205. WIMSHURST, H. W. (ASSAM COMPANY), 2 East India Avenue, London, E.C.—Coin and Disc Counter.

2206. CAMERON, LIEUT. - COL. D. R., R.A., Sheerness.—(1) Improved Optical Instruments. (2) A Double Focusing Telescope.

2207. CURZON, HENRY, 61 Lincoln's Inn Fields, London, W.C.—(1) The Translucent Sun Dial. (2) Curzon's Manifest Rain and Dew Gauge, denotes $1\frac{1}{16}$ in. of rainfall at a glance, in degrees of $\frac{1}{16}$ th of an inch—first degree protracted and subdivided for dew, &c. Compressible rubber tube within glass as safeguard against fracture by frost. (3) Curzon's Basculine Rain and Dew Gauge,

holds $1\frac{1}{2}$ in. of rain, denotes 80 degrees at a glance, remainder to be poured into a jug or returned for measurement, and two quantities added together. Compressible tube within glass tube.

2208. ROYAL METEOROLOGICAL SOCIETY, 30 Great George Street, S.W. (**WILLIAM MARRIOTT,** Assistant Secretary).—Typical Climatological Stations of the Royal Meteorological Society. (East of Central Fountains.)

AVERY, W. & T., Digbeth, Birmingham; and 14, 15 & 16 Cow Cross Street, London, E.C. (See Group XI, Queen's Gate Annex.)

AYRTON & PERRY, 78 Great Eastern Street, London, E.C. (See Group XIII.)

BACON, G. W., 127 Strand, London, W.C. (See Group XXX.)

BALFOUR & CO., Lane End Works, Longton, and Tamworth. (See Group III.)

BRAILSFORD, T. R., Thames Conservancy Office, 41 Trinity Square, Tower Hill, London, E.C. (See Group XIII.)

BRITISH ASSOCIATION COMMITTEE ON SCREW GAUGES (THE), Royal Mint, London, E. (See Group XXVII.)

BURROW, W. & J., 15 Seething Lane, London, E.C. (See Group XVII.)

CROOKES, WILLIAM, 7 Kensington Park Gardens, London, W. (See Group XIII.)

DALE, H. & E. J., 26 Ludgate Hill, London, E.C. (See Group XIII.)

DAY, EDWARD JOSEPH, Dorchester. (See Group XXIV.)

DENT, E., & CO., 61 Strand, London, W.C. (See Group XXVII.)

DILLON, JAMES, M.Inst.C.E., 8 Dawson Street, Dublin. (See Group III.)

FIELD, J. & J. C., Lambeth Marsh, London, S.E. (See Group XI.)

GLOBE ELECTRICAL & ENGINEERING CO. (THE), 20 Dartmouth Street, Westminster, London, S.W. (See Group XIII.)

GREGORY, WILLIAM, 51 Strand, London, E.C. (See Group XXV.)

HEDICKE, M., & CO., 3 Adelaide Place, London Bridge, London, E.C. (See Group XVII.)

HOLLANDS, SYDNEY H., Lock Villa, Lock Street, New Brompton, Chatham. (See Group VIII.)

JOBY, JOHN, 43 Pembroke Road, Dublin. (See Group XV.)

KENDAL & DENT, 106 Cheapside, London, E.C. (*See Group XXVII.*)

KENDALL, J. A., Middlesborough, Yorkshire. (*See Group XIII.*)

MACGEORGE, E. H. (late), Melbourne (Agents, **McLEAN BROS. & RIGG**, 52 Queen Victoria Street, London, E.C.). (*See Group II.*)

MACKENZIE, D. F., Morton Hall, Midlothian, N.B. (*See Group I.*)

MILLER, HERBERT P., 121 Fleet Street, London, E.C. (*See Group XXV.*)

MILLER, LESLIE B., 82 Hatton Garden, London, E.C. (*See Group XIII.*)

SCHÄFFER & BUDENBURG, 1 Southgate, St. Mary Street, Manchester. (*See Group IV.*)

SENNETT, A. R., & CO., 62 Hatton Garden, London, E.C. (*See Group XIII.*)

SUGG, WILLIAM, & CO., Vincent Works, Westminster, London, S.W. (*See Group XV.*)

WATKIN, MAJOR H. R.A., Royal Gunpowder Factory, Waltham Abbey, Essex. (*See Group XXV.*)

WHITFIELD, CHARLES, Kettering, Northamptonshire. (*See Group XIII.*)

WOOD, MISS, Elmswood, Beckenham, Kent. (*See Group XXVI.*)

WRIGHT, ALEX., & CO., 55, 55a, & 56 Millbank Street, Westminster, London, S.W. (*See Group XV.*)

PHOTOGRAPHY.

BY CAPTAIN W. DE W. ABNEY, R.E., F.R.S.

In reviewing the progress of photography for the last twenty-five years, the improvements and advances are so many and great that it will be only possible to allude very briefly to any one of them; and it must not be presumed, because an allusion to a process is short, that its importance therefore is small. We shall first call attention to the processes used in the production of negatives, and then treat of those processes which give us prints from such negatives.

Twenty-five years ago the wet-plate process may be said to have held a complete sway over the photographic world, the dry-plate processes being few and their followers limited in number; the old calotype and daguerreotype processes were then regarded as things of the past. Let it be remembered that the outline of the wet-plate process consisted of coating a glass plate with a film of collodion which contained a certain quantity of some iodide which was soluble in alcohol and a very small proportion of similarly soluble bromide, and that this film was immersed in a solution of silver nitrate which, by well-known chemical decomposition, formed minutely subdivided iodide of silver and bromide of silver in it. Such a plate, after exposure in the camera, was "developed" by reducing, by means of a reducing agent such as ferrous sulphate, the silver-nitrate solution which clung to the surface of the film, the reduced metallic silver depositing on the parts acted upon by light. When "dry plates" were used, the wet plate was, after taking out of the bath, washed, and some preservative substance, such as albumen, poured over it and allowed to dry. In this case the development of the image was usually conducted by means of plain pyrogallie acid at first, which reduced the minute quantity of silver nitrate left in the film, and was then followed up by the application of a solution of the same reducer, to which a solution of silver nitrate was added. The soluble silver salt in this case was reduced in exactly the same manner as that already stated for the wet plate.

The processes, which depended on dipping an iodized film into a solution of silver nitrate, appeared as if they would have no rivals until 1864, when Sayce & Bolton published the germs of a process which was to revolutionise the production of negatives. The plan was to cause the sensitive salts to be suspended in collodion, by adding directly to a collodion, containing soluble bromide, a solution of silver nitrate. By this means the collodion containing the sensitive silver salts could be at once poured as a film over the glass plate, and, after washing, was ready for exposure in the camera. Sayce subsequently improved the first crude formula to one which gave a really workable process. The development in this case was carried out somewhat differently. Some years before, a method of development had been suggested in America, and had been worked out into a practical form by Major Russell. It consisted of applying to the exposed film an alkaline solution of pyrogallol, which, when properly restrained, reduced the exposed silver salt (in this case bromide) and its contiguous particles to the metallic state, leaving the unexposed portions intact. These latter, as in the wet process, were removed by a solution of hyposulphite of soda or of cyanide of potassium. This method of producing emulsions in a collodion at once did away with the uncertainty which attended the use of the solution of silver nitrate, into which the films were dipped in the wet-plate process; for each plate so dipped reduced the strength and rendered it liable to contamination from foreign and noxious matter. The possibility of doing away with the silver bath was a great matter in photography. The full value of this process was not acknowledged, however, for some eight or ten years, when Carey Lea, Stuart Wortley, and others took it up, and made it practical and easy. In 1874, however, a still further improvement was effected by Bolton, for in that year he showed that the solvents of the collodion containing the suspended silver salt could be allowed to evaporate, all extraneous salts eliminated by washing, and the pellicle again be dissolved. Such an emulsion could be applied to the glass plate without any subsequent washing. In fact, a bottle of this emulsion, glass plates, and three or four bottles containing the needful developer and fixing

solution, was the only equipment necessary beyond camera and lens for the tourist photographer, who could expose his plates by day, and develop by shaded candle-light. Three years before this happened, however, a communication was made to the photographic world which was destined to throw this and every other negative process into the background. In 1871 Dr. Maddox published an account of a method of suspending or emulsifying silver bromide in gelatine, and applying this to the glass plate: not only did he publish, but he actually produced by his plan negatives of most excellent quality. The seed was sown, but for two years it lay dormant. In 1873, Mr. Burgess sold commercially such gelatine emulsion, but kept the method of its preparation to himself. In the following year Mr. Kennett published his method of attaining the same end, and subsequently issued dry plates made by it. Four years passed away—some extolling the plates, others condemning them—when Mr. C. Bennett appeared on the scene, and a new era for instantaneous photography dawned. He freely gave to the world his discovery, which was that by keeping the gelatine containing the silver salts liquefied at a low temperature for some three to seven days, an extraordinary sensitiveness to light was produced. The photographic public at once seized the idea, and progress has consequently been made in giving the process not only increased certainty but increased sensitiveness. The method adopted so far was to dissolve soluble bromide in a gelatine solution, then to add to it silver nitrate in water, allow the gelatine to set, and then to wash out all the salts which were soluble. In June 1879, Abney showed that a sensitive emulsion could be made by merely precipitating silver nitrate by a soluble bromide in a large bulk of water, collecting the precipitate, and mixing it with liquefied gelatine. Whilst trying this last process in August of the same year, Dr. Van Monckhoven, of Ghent, found that in lieu of keeping the gelatine liquid, as in Bennett's process, the same rapidity could be attained by treating the precipitated bromide with ammonia. This is the foundation of many modifications, and may be considered one of the stepping stones which have led to that present state of perfection to which gelatine plates have arrived. In 1879 Mr. Mansfield first published the fact that raising the gelatine solution to boiling point might be resorted to, whilst Bolton further showed that greater safety in procedure was attained if the emulsified silver salt was boiled with but a slight amount of gelatine, the remaining necessary amount being subsequently added.

It has already been mentioned that Major Russell brought to a practical form the mode of development known as the alkaline development. As lately as 1877 a new developer was discovered almost simultaneously by Mr. Carey Lea, of Philadelphia, and Mr. William Willis. This is now known as the ferrous oxalate developer, and is one of an exceedingly powerful nature, and yields negatives of great beauty. Like its predecessor it reduces the silver salt *in situ*, and does not build up the image from silver nitrate on the film. In 1881 Abney showed that the power of this developer for bringing out details with but short exposure was wonderfully increased by the addition of a few drops of a solution of hyposulphite of soda; and in 1880 he also showed that that strongly reducing body hydroquinone might be substituted for pyrogallol in the alkaline developer. Many changes in the organic salts of iron used as reducing agents were tried and experimented with, but we need only mention the ferrous citrate, the ferrous citro-oxalate, and the ferrous tartrate as examples, all of which gave, or were supposed to give, special qualities to the negative. At the end of last year Mr. Arnold Speller showed that hydroxylamine might be used in conjunction with an alkali as a reducing agent. This substance, which is difficult to prepare, has as yet to be more experimented with in order to render it commercially useful, more particularly as its high price is against its universal employment.

Leaving the negative processes, in which such vast and definite progress has been made, we must next advert to the printing processes, and of these there have been a large number all brought more or less to a state of perfection. Passing over the production of prints in silver on albumenized paper, the first process to which attention should be drawn is what is known as the carbon process. Monge Ponton, in 1837, stated, that if paper were saturated with bichromate of potash and dried, and then exposed to light through a drawing, a facsimile of the latter was produced, viz. as a white picture on an orange ground. Shortly afterwards, Bequerel announced that paper sized with starch iodide, and soaked in a solution of the same salt, was more sensitive than ordinary paper. In 1859 Pouncey described a process in which gelatine and pigment was used, light causing insolubility in the film, and an imprisonment of the pigment

in the film so rendered insoluble. Fargier, Blair, and others still further improved on this idea. J. W. Swan, in 1864, however, was the first who rendered the production of prints a commercial possibility. It had before been recognised if a paper coated with gelatine, pigment and bichromate of potash were exposed to light, that the insoluble parts remained on the outside surface of the gelatine and the soluble next the paper. What was required was to enable the soluble gelatine to be removed without injuring the insoluble portion, and this necessitated allowing warm water free access to the gelatine next the paper. To effect this, Swan prepared a gelatine paper which, after exposure beneath a negative, he cemented by india-rubber to some impervious surface. When placed in warm water the paper could be stripped away, and the soluble gelatine washed away, thus leaving a print on the rubber surface. This print he retransferred to its final support of paper, dissolving away the india-rubber. In 1864 J. R. Johnson did away with the rubber surface, merely cementing the gelatine pigment to an impervious surface by air pressure. The adhesion to the metal plate (which he used) was so complete that on placing it in warm water, the paper backing peeled off, and the picture was developed. Mr. J. R. Sawyer, in 1874, used an impervious paper on the same principle, and further improved the process. It would be out of place to record any other minor improvements which were effected from time to time. It is sufficient to say that ever since Swan's patent the process has been commercially workable and successful.

Another quality of bichromated gelatine after exposure to light is that of being capable of taking greasy ink where light has acted after immersion in water. This fact was noted by Paul Oréloth in 1854. Joubert, Tessie de Motay, and Marechal, of Metz, seem to have been the first to produce half-tone about 1865; and to transfer such half-tone pictures in ink to paper by means of the lithographic or printing press. The drawback in these greasy ink processes seems to have been the tenderness of the gelatine films used for obtaining impressions, such films only lasting for a few pulls in the press. Albert, of Munich, hardened the gelatine film by coating glass with bichromated gelatine, and exposing the back surface to light through the plate. Practically this is the foundation of all the photo-mechanical printing processes now extant. In some cases hardening has been resorted to by other methods, and in others the films have been removed from the plates on which they were prepared, and after exposure to the back have been cemented on to metallic plates from which impressions have been obtained; notably is this the case in Ernest Edwards' Heliotype process. No great improvement over that of Albert of Munich, has, however, to be noted.

Another totally different method of obtaining prints from a gelatine print is the Woodbury process, which Mr. W. Woodbury brought out in 1864, at a time when Mr. J. W. Swan was also working in the same direction. The principle of the Woodbury process is that a picture in gelatine is made. Since the soluble portions are washed away, such a print is in relief. This relief can be used as a mould from which to make an electrotype, or it can be pressed into yielding metal. The first was Woodbury's original method, which he afterwards modified by adopting the second plan. Such a mould, when filled with pigment and gelatine and pressed against a flat paper surface, allowed facsimiles of the original gelatine print to be reproduced in any quantity, and this is the bald outline of the Woodbury process which has been so extensively used. Mr. Woodbury made a further modification by reproducing the negative in gelatine, which then became a mould, covering it with tin-foil, and using that from which to reproduce the pigment prints. This he calls Stannotype. Further, in connection with bichromated gelatine, we have, about the year 1860, the introduction, by Col. de C. Scott and Osborne, of photo-lithography. A transfer in greasy ink was made on paper coated with bichromated gelatine from a negative, and this was applied like an ordinary lithographic transfer to the lithographic stone or to zinc. Asser, it may be said, in 1859, had made some progress towards the same end.

Returning to printing with silver salts, we find that in 1864 G. W. Simpson introduced the process known as collodio chloride. This was a process in which silver chloride was emulsified in collodion with an excess of silver nitrate and citric acid. This collodion, when poured over glass or paper, enabled most exquisite prints to be produced, which, when properly treated, show up to the present time no signs of fading. It should be remarked that Gaudin had previously experimented in the same direction. Following in the same wake, in 1881, Abney showed that when citrate of silver and chloride of silver were emulsified in gelatine, the same

good qualities were to be found. This last process is still young, but is receiving attention, which it is believed will cause it to hold a prominent place in the production of prints in silver.

The development of prints on paper has long been known, the drawback to this method being the difficulty of obtaining a pure white, which is an essential in the high lights of a print. It had been shown as early as two years ago that prints on gelatine chloride emulsion was possible, but it was not till the end of 1884 that Marion & Co. brought into the market a paper, which on development enabled prints to be produced which vied with those on albumenized paper. It is too early to speak of the future of this process, but there is no doubt if simplicity and rapidity of production are good qualities which should recommend a process, that this rapid printing paper should become one of the principal features in the practice of photography.

Sir John Herschel had in the early days of photography shown that the ferric salts were changed by light to the ferrous state, and that such images might be developed by chemical means. Thus red prussiate of potash gave a blue image when light had acted on a paper which had been washed over with ferric citrate. The production of "blues" is still practised, but a much more important process was brought out in 1872 by W. Willis, dependant on the reducing power of the ferrous salts on platinum salts. If a paper be coated with ferric oxalate and a chloro-platinite of potassium, and be then exposed to light through a negative, the light will reduce the ferric salt to the ferrous state. When so reduced, if the paper be floated on a warm solution of neutral potassium oxalate, the ferrous oxalate is at once dissolved, and at the moment of solution reduces the platinous salt to the metallic state, depositing it on the paper. Willis showed that by this method of procedure a picture could be built up, and hence introduced the name and process of platinotype. The process is an extremely interesting one, and one which bids fair to be even more extensively adopted than it is at the present time. It gives permanent prints, and is rapid in printing and easy in execution if but ordinary care be taken. The brief space to which this article is naturally confined prevents the possibility of giving any great minutiae in describing processes, but we think sufficient has been written to show that in the last twenty-five years photography has not been at a standstill, but has advanced with a rapidity which it can scarcely be hoped will be maintained till 1910.

GROUP XXIX. PHOTOGRAPHY.

[For Applications of Photography to Printing, see also Group XXVI.; for Photographic Lenses, see Group XXVIII.]

SOUTH CENTRAL GALLERY.

2225. **HOUGHTON, G., & SON, 89** High Holborn, London, W.C.—Modern improvements in photographic apparatus.

2226. **WARNERKE, L.,** Silverhowe, Champion Hill, London, S.E.—(1) Various Photographic Processes based on newly discovered properties of gelatine emulsions. (2) New Photographic Shutter. (3) Sensitometer. (4) Roller Dark Slides.

2227. **MORGAN & KIDD, Kew Foot** Road, Richmond, Surrey.—Argentio Gelatino-bromide Process, as applied to enlarging on paper, porcelain, canvas, &c.

2228. **COMMON, A. A., 63 Eaton** Rise, Ealing, London, W.—Photographs of Moon, Planets, Stars, and Nebulae, comprising a series of original negatives on one scale, and various enlargements of these and other Celestial photographs.

2229. **HENDERSON, A. L., 49 King** William Street, London, E.C.—Ceramic Enamels and Apparatus for making emulsion and coating plates.

2230. **NEWTON & CO., 3 Fleet Street,** London, E.C.—(1) Patent Mineral Oil Magic Lanterns. (2) Patent Refulgent 3-Wick and 4-Wick Lamps for lanterns. (3) Binnial and Triple Lime-Light Lanterns. (4) Lantern Polaroscope for projection. (5) New check-action lime movement for lime-light jets. (6) Improved Appliances for apparatus of projection.

2231. **MIDDLEMISS, WILLIAM,** Holmfild Mill, Thornton Road, Bradford.—Light and Compact Patterns of Portable Folding Cameras, having long focus, reversing back, double swing back, and all movements required for photo cameras.

2232. **CUSWORTH, C., 30 Ellington** Street, London, N.—(1) Balloon [captive] Photographic and Signalling Apparatus. (2) Tourists' Knapsack Set. (3) Concave Sensitive Plates. (4) Revolving Dark Back and Spring attaching exposure shutter to camera.

2233. **HOPKINS, J. & A. G., Photo-**graphic Studio, Hoddesdon.—Simplex Slide and Reversible Camera Back; also Simplex Camera, with novel improvements in the form of same; also showing method of adapting the above slide and back to any camera.

2234. **COLLINS, C. G., 56 Cochrane** Street, St. John's Wood, London, N.W.—Improved Photographic Apparatus.

2235. **SHAW, GEORGE, 3 Cawley** Road, Victoria Park, London, E.—Instantaneous Shutter, and marine views taken with same.

2236. **GOSLIN, S. B., & ATTWOOD,** W. S., Chase Side, Southgate, N.—Improved Dark Slide Cameras.

2237. **BARKER, G. E., High Road,** Chiswick, London, W.—Photographers' Electric Light Apparatus.

2238. **GAULY, EDMUND G., 11** Victoria Grove, Kensington Gate, London, W.—A Retouching Machine, and improvements in camera apparatus.

2239. **SWIFT & SON, 81 Tottenham** Court Road, London, W.—Photographic Apparatus, Microscopes, and Microscopical Appliances.

2240. **ATKINSON, LEONARD, 285** Brockley Road, London, S.E.—Improved Apparatus for micro-photography.

2241. **BAPTY, S. LEE, 65 Blackheath** Road, Greenwich, London, S.E.—(1) Model of Photographic Enlarging Apparatus. (2) Microphotographs produced by the apparatus. (3) J. Lyon's Patent Combination Chromatic Stereoscope.

2242. **ROUCH, W. W., & CO., 180** Strand, London, W.C.—Photographic Apparatus, Materials, and Chemicals.

2243. **OUIN, WILLIAM, 4 'Laurel** Cottages, Waverley Road, Park Lane, Tottenham, Middlesex.—A Drop Shutter for taking instantaneous pictures of moving objects, with particulars of construction thereof, illustrated by drawing of same.

2244. **MONSELL, F. W., Eglantine,** Leeson Park, Dublin.—Circular Drop Shutter.

2245. **REYNOLDS & BRANSON, 14** Commercial Street, Leeds.—The Phoenix and Universal Photographic Shutters.

2246. **McKELLEN, S. D., 18 Brown** Street, Manchester.—Photographic Cameras and Changing Lamps.

2247. **LONDON STEREOSCOPIC & PHOTOGRAPHIC CO. (THE), 54** Cheapside, and 108 & 110 Regent Street, London, W.—(1) Various Photographic Apparatus for amateur use, showing the latest improvements. (2) Frames containing views taken by amateurs. (3) Carbon Photographs on opal.

2248. **SANDS & HUNTER, 20 Cran-**bourn Street, London, W.C.—(1) Patent Double Swing Back Cameras. (2) Patent Double Action Rack Cameras. (3) Patent Instantaneous Shutters. (4) Photographic Gun. (5) Improved Tripod Stands. (6) Books for sensitised plates and other photographic requisites.

2249. HARE, G., 26 Calthorpe Street, Gray's Inn Road, London, W.C.—Photographic Apparatus.

2250. SHEW, J. F., & CO., 88 Newman Street, Oxford Street, London, W.—(1) Patent Camera Adapter. (2) Patent Combination Camera. (3) Universal Camera Clip. (4) Novel Fitting for suspending camera horizontally on moving vessel, &c. (5) Eclipse Instantaneous Shutter. (6) Improved Reversing Top.

2251. GREEN, C. & L. V. FUDGE, Ivy Cottage, Stratford-on-Avon.—Patent Actinometer.

2252. HONEY, W. G., 3 High Street, Devizes.—An Improved Holder, and dark slides to be used therewith for sensitive plates; also an Improved Holder for manipulating a photographic plate.

2253. FURNELL, T., 1 Matlock Villas, Lordship Lane, East Dulwich, London, S.E.—An Adjustable Instantaneous Shutter for photographic purposes.

2254. SAYCE, B. J., Redcross Chambers, Liverpool.—The Collodio-Bromide Process.

2255. JAMES, T., 32 Great George Street, Liverpool.—Elastic Photo Printing Blocks for typographic press.

2256. SAMUELS, T., Linden House, Hadley, Barnet.—(1) Apparatus for holding dry plates or films before, during, and after exposure, and for changing them in the photographic camera. (2) Improvements in photographic cameras, whereby double swing backs and sliding fronts are dispensed with. (3) Plate Box for packing dry plates.

2257. MACBETH, NORMAN, Victoria Foundry, Bolton.—Process for producing printing surfaces on blocks by means of gelatine photo-reliefs.

2258. WOODBURY, TREADAWAY, & CO., Limited, 116 & 117 Great Saffron Hill, London, E.C.—Stannotype Photographic Printing Process.

2259. PHOTOGRAPHIC SOCIETY (THE) (Secretary, W. F. DONKIN), 97, Upper Tulse Hill, London, S.W.—Collection of old Photographic Pictures, Processes, and Apparatus, illustrative of the history and progress of photography.

2260. WOODBURY PERMANENT PHOTOGRAPHIC PRINTING CO. (THE), 157 Great Portland Street, London, W.; and Castlebar, Ealing, W.—Woodbury type and carbon printing, examples of each process, showing the connection between the two processes.

2261. PLATINOTYPE CO. (THE), 29 Southampton Row, High Holborn, London, W.C.—(1) Work by licensees of the

Company. (2) Image visible before development. The developed image, consisting of metallic platinum only, is unalterable by atmospheric influences and by all re-agents except aqua-regia. Results very artistic and absolutely permanent. Process simple, rapid, and easily worked.

2262. PAGET PRIZE PLATE CO. (THE), Ealing, near London, W.—(1) Gelatino-bromide of silver Dry Plates of extreme sensitiveness for instantaneous photography. (2) Negative and Positive Photographs, exemplifying rapidity and quality of the Paget Prize Plates.

2263. SWAN, J. W., Bromley, Kent.—(1) Carbon printing, or Autotype, for production of permanent photographs in pigment illustrations of process by models and examples. (2) Illustrations of Photo-mezzotint, also known as Woodburytype: a new method of printing from photographically produced intaglio plates. (3) Illustrations of Photogravure, photographically produced, intaglio plates for copperplate printing. (4) Illustrations of Photo-block-printing, photographically produced blocks for letter-press printing. (5) Illustrations of Collodio-citro-chloride process. (6) Illustrations of Gelatino-bromide process. (7) Examples of application of gelatine rendered insoluble by chrome alum.

2264. SPILLER, ARNOLD, 2 Mary's Road, Canonbury, London, W.—Gelatino-chloride of silver Transparencies developed with Hydroxylamine.

2265. WALERY (COUNT OSTROG), 5 Conduit Street, New Bond Street, London, W.—Photos, plain and carbon, and permanent portraits on enamel.

2266. VAN DER WEYDE, HENRI, 182 Regent Street, London, W.—Illuminating artificially objects to be photographed. (2) Improvements in producing netted negatives.

2267. WORTLEY, COL. STUART, South Kensington Museum, London, S.W.—(1) Improved Instantaneous Shutter. (2) Improved Apparatus for preparing and washing sensitised gelatine, and for coating glasses therewith. (3) Improved Stove for keeping the gelatine fluid for any time at any specified temperature, and for the final drying of the sensitive films. (4) Specimen pictures.

2268. HART, F. W., 8 & 9 Kingland Green, Dalston Junction, London, E.—(1) Patent Photographic Cameras of specially long focus. (2) Patent Tripod Stands, folding and sliding. (3) Draining and Drying Frame, in combination with trough for washing negatives. (4) Plate Holder. (5) Magnesium Light Machine. (6) Celluloid Trays for Developing, &c. (7) Model of Photographic Pavilion or Portable Studio.

2269. **CLARKE, ARCHER**, St. John's Cottage, Wandsworth, London, S.W.—(1) Metal Press for emulsion work. (2) The Harrison-Clarke Bijou Camera. (3) Packing Machine for gelatine and other dry plates.

2270. **MARION & CO., 22 & 23 Soho Square**, London, W.; and **CADETT, J.**, 84 Grove Lane, Camberwell, London, S.E.—(1) Recent Photographic Apparatus. (2) New or Improved Pneumatic Arrangements for facilitating the uncapping or exposing, and tapping or shutting the lenses used in apparatus for depicting persons or objects by photographic means.

2271. **PHOTOGRAPHIC ARTISTS' STORES (THE)**, 43 Charterhouse Square, London, E.C.—(1) P. A. S. Camera. (2) Smith's Camera. (3) Charterhouse and Uranium dry plates for negatives and transparencies, and for positive printing on plain and smooth opal.

2272. **BERNSTEIN, W.**, 72 Finborough Road, South Kensington, London, S.W.—Photopointure. A new method of reproducing oil paintings from the ancient and modern masters to the original or any size [painted by hand], by an entirely novel process.

2273. **DUNMORE, EDWARD**, 1 Beacon Hill, Camden Road, N.—A Landscape Negative and Print therefrom, taken entirely by lunar light in a suburb of London.

2274. **SAFE, FREDERICK**, 28 Grove Road, Holloway, London, N.—Enamelling of coloured photographs.

2275. **LONG, C. A.**, 72 Piccadilly, London, W.—The Photolith.

2276. **ROBERTSON, H. R.**, 1 Steele's Studios, Haverstock Hill, London, N.W.—Diotype.

2277. **FOXLEE, E. W.**, 22 Goldsmith Road, Acton, London, W.—Examples of the continuing action of light in carbon printing, showing that the action is dependent upon moisture in the tissue, and that it is accelerated by heat.

2278. **MAYALL, J. P.**, Park Lane Studio, 548 Oxford Street, London, W.

—(1) The application of a single lens to life-size portraiture. (2) Enlarged photographs from Mr. Mayall's series of Artists at Home.

AYLING, JOSEPH JAMES, 4 Crane Court, Fleet Street, London, E.C. (See Group XXVI.)

DALLAS, D. C., 12 Crane Court, Fleet Street, London, E.C. (See Group XXVI.)

GAILLAND-MASON, ROBERT, Hambleton House, The Promenade, Isle of Man. (See Group XXVIII.)

GARBETT, E. L., 3 Myddelton Square, London, E.C. (See Group XXVIII.)

HANCOCK, C., 3a Ennersdale Road, Hither Green, Lewisham, London, S.E. (See Group XXVI.)

HARTLEY, W., Royal College of Science, Dublin. (See Group XXVIII.)

INDESTRUCTIBLE ENAMEL COMPANY, Limited (THE), 85 Dudley Road, Wolverhampton. (See Group XXIII.)

KEW COMMITTEE OF THE ROYAL SOCIETY (THE), Kew Observatory, Richmond, Surrey. (See Group XXVIII.)

MEISENBACH CO., Limited, 31 Farringdon Street, London, E.C. (See Group XXVI.)

SPRAGUE & CO., 22 Martin's Lane, Cannon Street, London, E.C. (See Group XXVI.)

STANLEY, W. F., 5 Great Turnstile, Holborn, London, W.C. (See Group XXVIII.)

STEWART, JAMES HENRY, 408 Strand, London, W.C. (See Group XXVIII.)

WILKINS, T., 3 Meredith Street, Clerkenwell, London, E.C. (See Group XXVI.)

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GROUP XXX.—EDUCATIONAL APPARATUS.**EAST GALLERY ANNEXE.****CLASS CLXII.**

Models and Apparatus.—Appliances used in Primary, Scientific, Technical, and Artistic Instruction.

2306. JOHNSTON, W. & A. K., Edina Works, Easter Road, Edinburgh; and 5 White Hart Street, Warwick Lane, London, E.C.—(1) A Geographical Globe at the various stages of manufacture. (2) Globe Covers and Maps, showing the different printings in colours. (3) The Royal Atlas printed in oil colours.

2307. CLARKE & SHRAPNEL, 37 Walbrook, London, E.C.—Imperishable Diagrams for educational purposes.

2308. CUTTELL, F. G., 49 Bedford Street, Strand, London, W.C.—Portable Apparatus for preparing sections of rocks, minerals, fossils, &c. for microscopical examination; also specimens of sections cut by the above.

2309. MILLIS, CHAS. THOMAS, M.Inst.M.E., 4 Northumberland Terrace, Regent's Park Road, London, N.W.—New method for setting out patterns for baths, ventilators, elbows, and other sheet-metal articles.

2310. RIGG, JAMES, 11 Queen Victoria Street, London, E.C.—Sectional Working Model of a Condensing Beam Steam Engine as used at pumping stations. The construction, action and principle of this class of engine can be studied from the model, which comprises steam cylinder, valves and motion, two double-acting pumps with rods, condenser, pump and feed pump, parallel motion, girders with top platform surrounding beam, supported upon six cast-iron columns and foundation.

2311. RICE, WILLIAM, 86 Fleet Street, London, E.C.—(1) The Mechanical Globe, for illustrating the alternation and varying length of day and night, and the causes and succession of the seasons. (2) The Selenotrope, for illustrating the phases of the moon. (3) Tellurian, with patent attachment, showing more clearly the limits of the illuminated hemisphere at the different seasons. (4) The Universal and Local Time Clock, showing universal time, and [by the same dial] the local time at one hundred of the principal stations of the globe.

2312. BACON, G. W., 127 Strand, London, W.C.—(1) Large Relief Maps of England, by a new patent process. (2) New Special Maps and Quarto Library Atlas of London and suburbs. (3) Improved Large-print Elementary Atlas. (4) Process of engraving maps on copper, in the different stages.

2313. BAUGH, E., 1 Thorney Villas, Pellatt Grove, Wood Green, London, N.—Simple Writing Frame for the blind.

2314. FRANKS, MISS F., 143 Camden Road, London, N.W.—Anti-sedentary School Table, adapted to any height, allowing the pupil to work freely standing, and drawing from the shoulder.

2315. RUNDELL, J. B., Science and Art Department, London, S.W.—Short-hand for Schools:—(1) An Alphabet of Short-hand Signs to aid in teaching children to speak, read, and write English, French, and German. (2) A Mode of Quick Writing, suited for common use, based upon the above-mentioned alphabet.

BROOKE, EDWARD, 1 West Avenue, Walthamstow, Essex. (*See Group XXVI.*)

KENDAL & DENT, 106 Cheapside, London, E.C. (*See Group XXVII.*)

STANLEY, W. F., 5 Great Turnstile, Holborn, London, W.C. (*See Group XXVIII.*)

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Catalogue No. 1231. See Exhibit No. 1231. Group XI.

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TOYS, SPORTS, &c.

BY EDWIN LESTER ARNOLD.

FERTILE as the last quarter of a century has been in new productions and fresh application of old ones, in scarcely any department of the Exhibition is this more manifest than in the various classes comprised within this group.

Out-of-doors recreation has been reduced to a fine art. We are no longer content with the few and simple games which formed the chief resource of previous years, but have introduced hitherto unknown exercises, and perfected those of an earlier period.

So universal has become the appreciation and patronage of various open-air sports that they have a literature of their own, a flourishing press, and support a gigantic establishment of manufacturers and artisans who live by the fabrication of the various necessary implements and accessories of each.

In the field, again, improvements have been abundant in all the apparatus used in hunting, fishing, and shooting, and the limits which the sportsmen of the mid-century era set as the furthest point to which human skill might attain, have been cast into the background by recent achievements.

Turning to a third class of subjects, we see that, while skill and science have been actively employed in perfecting our more serious diversions, the recreations of the evening, scenic and dramatic effects, the magic lanterns and their kindred, have not been neglected by assiduous brains of inventors.

Class 163 is devoted to Toys, Games, and Exercises, comprising within its limits a world of variety and ingenuity. The first is the special realm of the children. In it we cannot help noticing, what was to be expected, that the engrossing studies of their elders have tinged the nature of the juveniles' implements of amusements. Ingenuity, talent, taste, and fun are plentifully displayed, yet toys are perhaps less toys than they were once. We miss, or notice but seldom, the massive playthings or substantial forms of other days. In their place have arisen a class of objects suggesting for the most part some scientific truth, or pointing to a physical moral. Here the partially successful experiments of an aeronaut have been pilfered from his study table to infuse life into winged artificial birds or insects. There again we have diminutive engines holding within their tin sides those secrets which it took Stephenson and Watt years of thought to unravel; or the graceful toys of to-day embodying phenomena which yesterday the electrician was proud to recognise as the highest result of his researches. Where our toys are conservative their form has in many cases been improved. Our national taste in wax dolls, for instance, is assiduously catered for by the peasants of the German Black Forest. Sonneberg in that district is the great centre of the special industry, and the quiet Thuringian village of Lauscha has supplied eyes and spun glass in a hundred forms with very little variety since 1595.

Paris rules the fashions in dolls' clothing as in the more exalted branches of the science, and a perennial stream passes through the French capital. From Holland come most of our cheaper wooden dolls.

Berlin supplies the lead soldiers dear to the hearts of boys, and still colours them with the traditional colours of continental uniforms in the first years of the century. Wurtemberg is unrivalled for toys in tin, such as coaches, cabs, and swimming ducks or fishes that come to the magnet. Saxony fills our Noah's arks with wooden animals, turned out by the thousand, the better carved forms of birds and beasts again marking the way in which the Swiss shepherd occupies his surplus time. All these forms have undergone but slight change for a long period. It is rather in our home manufactories of Norwich, Sheffield, and Birmingham that novelties have been introduced. Glancing through the long lists under the heading of athletics, there seems hardly one department where improvements have not been made, while several of our modern sports were practically unknown twenty-five years ago. Cricket, an example of the

first, has maintained an unvarying popularity since D'Urfe mentions it in the beginning of the 17th century, and is still our national pastime in spite of a host of rivals. Base-ball, a better and more scientific amusement than rounders, has found patrons among us. Football fills the long winter months with healthy amusement, and after a period of neglect is once more in the front rank of athletics. Golf and hockey, those modern forms, as Strutt tells us, of the ancient game of "bandy-ball," hold their own; the former very little altered from a game which the Roman legions introduced. Raquets and fives, in our public schools, boxing and fencing, curling in the North, when the lochs are frozen over, *La Crosse* from the West; a recent importation, polo, mentioned in the oldest Eastern romances, archery of remote antiquity, and many other games and sports demand their appropriate paraphernalia and implements, in the construction of which large numbers of men, women, and boys are employed, and great and thriving industries nourished. Lawn tennis, though almost unknown in the present sense of the term a few years ago, has taken the place of croquet, and gives wide scope for invention to the manufacturers. Raquets, balls, nets, net poles, scoring boards and court-marking machines have all been brought to the highest state of perfection, and present in their variety of form and construction, endless choices to fastidious players.

In gymnastic apparatus we have made large strides since Volker early in the century established his first *Palæstra* in the metropolis, and Elias a little later popularised the study.

Appliances for the exercise and strengthening of muscles and the cultivation of physical grace are now in harmony with good sense. The leading makers supply indoor recreation of this kind appropriate to the finished athlete in the redundancy of his powers, or the most delicate children, and within the last year or two much patience has been devoted to contriving mechanical means, whereby the characteristic exertions of open air exercises may be reproduced with a certain amount of success in the chamber. With "wind and limb" cultivated by gymnastic exercises and amply indulged by out-of-door recreations in the fine months, we are loth to give up our exercise in the winter time. Here the purveyors of skates, sledges, and snow-shoes show what they can do for us.

The art of skating is of considerable antiquity. When Edward I. was on the throne the citizens of London amused themselves on the ice, pointed staves in hands, having sheep's thigh bones strapped to the soles of their shoes, with which they propelled themselves along. From this rude commencement of the noble sport has developed the modern steel strapless skate, a model of lightness and perfection. When a really practicable means of obtaining artificial ice surfaces shall have been discovered, the skater will have nothing to complain of.

At the head of all indoor pastimes stands the popular amusement of billiards—a game the Strutt regards as the modern form of an old English game of bowls brought under a roof and played on a table in place, of the former open court. Convertible billiard tables, that can be used either for ordinary purposes or for the game by the removal of a cover, have very largely increased the number of players in private houses. Fifty years ago thin metal sheeting often lay under the green cloth, and listed cushions surrounded it. Every good table now has a solid bed and "fast" rubber cushions.

Guns and their ammunition being ranged in a previous class, it only remains for us here to speak of the lesser accessories of the sportsman's outfit. Firstly, in regard to himself and his personal comfort, much has been done of late to make him indifferent to the weather. When the percussion gun was in fashion the shooter relied for serviceable clothing on stout clothes, fustians, and velveteens; now he dons cunningly prepared "waterproofs" above, and patent boots on his feet.

Game bags, cartridge bags, gun cases, belts, leggings and a hundred other sundries, all owe something to the invaluable and widespread india-rubber. The shooter cleans his guns with ingenious brushes in leather, wire, or bristle, and lubricates them with a variety of oils, the names of which find no place in Col. Hawker or Squire Osbaldiston's sporting works. Afield he takes his collapsible silk hawk kite, with which to make game "lie" when wild. He even carries, if of the most luxurious school, his folding seat with parasol attached, dainty luncheon baskets and flasks, all of them unknown to his forefathers. The wild-fowler relies very largely upon artificial decoy birds to draw down quarry to within shot of the spot where he lies hid. These are made in many forms, of hollow vulcanite, wood, tin, or other material, and though something of the kind has been known from the most remote antiquity, modern decoy birds are the most

perfect and convenient of their kind. Yet another class of shooters, who patronise neither stubble, heather, or sea-shore, find their amusement in the enclosures where pigeon matches are held. Were antiquity an argument, they might find one for their diversion in the mention made of a pigeon match (the competitors of course using bows and arrows) in the *Iliad*, when the funeral games of Patroclus are being described. The necessary traps for the freeing of the birds have recently been the object of considerable attention.

The very recent introduction of "clay pigeons," or saucer-like discs of baked clay, spun into the air by springs, seems likely to permanently establish a new pastime, free from the objections that are urged against the use of natural birds. Patented in this country in 1881, the original make of "clay pigeons" has already practically driven from the field the glass ball trap and other targets of like nature.

In a country such as England game requires much protection from the poacher, who stumbles over one of those clever alarm guns set to betray his midnight raids, or from winged and four-footed foes who have to be netted and trapped, as well as against uncertain weather, which makes patent coops, shelters, feeding-houses, and artificial "mothers" invaluable, by assisting in the rearing of a good head of game. A trap to take the place of the cruel steel jaw-trap has yet to be invented, though several recent forms show cleverness in design.

The rod angler's needs are so simple that hardly any marked innovation has been possible in them, even since the Assyrians dipped their lines in the tributaries of the Euphrates, and Aulonius dilated on the salmon of the Moselle; yet small discoveries and amendments are constantly being made. The rod, in the hands of primitive savages, the first handy cane-shoot or willow-sapling available, has developed through the home-made oven-baked hazel wand which that excellent Prioress and admirer of the gentle craft, Dame Juliana Berners, recommends, to the work of art in lancewood, hickory or split rattan which our best makers now turn out. It may be noticed that the modern perfection of the science of angling, nowhere pursued so enthusiastically as in England, nor anywhere else supporting such an array of skilful tradesmen, has dedicated certain rod woods to specific fishes. Our greenheart is chiefly used for the capture of salmon and trout; the familiar clouded bamboo makes the best pike trolling rods; while for perch and coarser fish, hickory or common bamboo serves, with white cane for dace and small fry. A perfect rod, whatever its material, should be thoroughly seasoned, capable of resisting weather or wear, while retaining an even spring and pliability under use. Those made of split cane, cunningly bound together, are believed by good judges to fulfil these conditions well. Portable rods, rods that pack into the portmanteau or travelling trunk, or walking-stick rods, and others of the kind, have become common of late, the rods of the present time being more carefully and artistically finished than ever before. Reels were in use in China before the eleventh century; their present forms are complex, "multiplying," "check," and a score of other devices, occasionally trivial, characterise them. Lines are very various, and some new water-proofing processes have been introduced. Attention of makers is being constantly directed to the perfecting of lines, fine, strong and elastic; hair and silk being very difficult to supersede in these qualifications.

The fisherman's tackle, as might be expected, is almost entirely of British manufacture. Our makers are the most famous and artistic men in the world. The tackle stall, with its array of beautifully finished implements of the craft, the neat and multitudinous store of flies for the fastidious to choose from, the gaudy salmon lures and the cunning "artificial baits," with a hundred and one sundries of more or less usefulness, cannot fail to attract attention. The sea fisherman demands stronger and heavier gear, and is equally well catered for.

The various forms of hunting for which our shires are famous, support their special trades and workmen; those who follow these sports calling for protective clothing for themselves, horse clothing and shoes, stable fittings, kennel arrangements, leashes for dogs and hounds, whips and bugles, harness of sorts, safety stirrups and "saddle bars," and much else.

Lastly, Class 165 shows us much that has been done towards the perfection of theatrical scenery; and some striking instances of the exquisite finish and sterling excellency of the magic lanterns of the day.

GROUP XXXI. TOYS, SPORTS, &c.

EAST QUADRANT AND EAST GALLERY ANNEXE.

[For Sporting Guns, see Group XXV.]

2327. DE PONT & CO., 11½ Union Court, Old Broad Street, London, E.C.—Hard Enameline, a substitute for ivory for billiard balls, knife handles, pianoforte keys, &c.

2328. SAHL & CO., 36 Basinghall Street, London, E.C.—Novel Indoor and Outdoor Games.

2329. JEFFERIES & CO., 1 Lower Wood Street, Woolwich.—Improvements in cricket and lawn tennis bats and balls.

2330. MARTIN, M., & SON, 22 Great College Street, Westminster, London, S.W.—Improvements in the manufacture of footballs and racquet bats, football and other sporting boots.

2331. HAMPSON, W., West Hey, Rock Ferry, Birkenhead.—Mixing Marker for lawn tennis; an invention for mixing the liquid easily and without splashing.

2332. FORD, J. T., 6 Outram Road, Havelock Park, Southsea, Portsmouth.—Improved Spherical Joint and Screwed Point to keep the stumps one height and width throughout a match.

2333. PEACOCK, WILLIAM, 14 Queen's Head Street, Essex Road, Islington, London, N.—A new and improved Cricket Set for ladies' and children's use, called the Victorian.

2334. DENING, F., Chard, Somerset.—Apparatus for Scoring at cricket and other games, also Athletic and Race Telegraph.

2335. ANGLO-AMERICAN CLAY PIGEON CO., Limited (THE), 1 Bennett Street, St. James' Street, London, S.W.—Clay Pigeons, Targets and Traps.

2336. STANLEY, MORRISON, & CO., 9 Gracechurch Street, London, E.C.—Improvements in the manufacture of lawn tennis, racquets, and bats,—particularly in ability to record the games scored, on the face of the bat.

2337. BOORN-THOMPSON, H. G., Short Range, Manchester.—Patent Acme Cricket Stumps: made for club practice and amateur play in annealed steel or iron bottoms, and for children's play with hard or soft wood bottoms; especially useful for regimental parade grounds.

2338. EASTMAN, THOMAS, Walsington College, Fareham.—(1) Patent Adjustable Lawn Tennis Poles. (2) Patent Cyclops Lawn Tennis Poles.

2339. BEARD, R. R., 90 Fort Road, Bermondsey, London, S.E.—Self-centring Magic Lantern Slide Carrier.

2340. HENRY, R., 5 Salter's Hall Court, London, E.C.—Automatic Extensible Metallic Swings, in combination with horses, chairs, cribs, hammocks, and the like.

2341. SQUIER, F. W., 44 Stapleton Hall Road, Stroud Green, London, N.—Improvements in the construction of lawn tennis poles.

2342. GODDARD, T. W. (Agents, SLAZENGER & SONS, 56 Cannon Street, London, E.C.)—Goddard's Patent Self-adjusting Lawn and Tennis Pole.

2343. BERESFORD, KENNEDY, care of MESSRS. COX & CO., 1 & 2 Craig's Court, Charing Cross, London, W.C.—Improved Means of holding chalk for facilitating the application of it to billiard cues.

2344. TRUSSELL, THOMAS, 4 Arrow Terrace, Fisher Gate, Nottingham.—Improvements in the methods of marking for billiards, and apparatus for carrying out the same.

2345. DAVIDSON & CO., Sirocco Works, Belfast, Ireland.—The North Patent Lawn Tennis Poles, and the North Racket Stand.

2346. MANBY, C. N. H., Oakhill, Bath.—New and Original Out-door Lawn Game of Denmark. For ladies and gentlemen, four to sixteen players. Lawn 30 ft. to 36 ft. by 20. No marking or mowing, and inequality of lawn immaterial. Played with cane ring, and has three different sets of rules. Also available indoors.

2347. BRYAN, FRANK, 38 Charterhouse Square, London, E.C.—(1) New outdoor game, Hildegard. (2) Champion Boxing Gloves. (3) County Cricketing Leg Guards and Batting Gloves. (4) Patent Lawn Tennis Racket-press. (5) County Lawn Tennis Rackets and Balls. (6) Sportsmen's Gaiters, &c.

2348. WESTERN MECHANICAL COMPANY (THE), Exeter.—Portable Exercising Machine or Mechanical Horse.

2349. KEMP, STEPHEN, 8 Holbeck Road, Kennington, London, S.W.—Bicycle Skates.

2350. JAKUES, J., & SON, 102 Hatton Garden, London, E.C.—(1) The Eclipse Lawn Tennis Court Markers. (2) The Eclipse Lawn Tennis Posts, Nets and Regulators. (3) The Club, Champion, Globe, Eclipse, and other pattern Lawn Tennis Bats and Implements.

2351. GILL, C. G., 8 Ronilly Road, Finsbury Park, London, N.—Lawn Tennis Posts, Rackets, Markers, and other requisites connected with the game.

2352. DEANE & CO., 46 King William Street, London Bridge, London, E.C.—(1) Gardiner's Simplex Lawn Tennis Poles. (2) Waterproof Nets and Centre Irons. (3) Monument and other Rackets. (4) Monument Balls. (5) Fairlions, Markers, Scorers, Stop-netting, &c.

2353. URRY, E. C., 52 Lambton Road, Hornsey Rise, London, N.—Improvements in self-lubricating roller skates.

2354. BLACK, W. T., Church Lane, Northampton.—Silent and Clearance Skittle Board with padded top. Hanging valence to stop rebound of played balls and skittles. Two angle pockets to receive ditto, which are with or without indiarubber bands.

2355. COLE, G., & CO., 19 Nicholl Square, London, E.C.—Improvements in mechanism for actuating mechanical automaton toys.

2356. MORRIS, T. WILSON, 87 Park Street, Grosvenor Square, London, W.—(1) An Apparatus to enable the blind to play cards. (2) Ergometer, a time-checking apparatus.

2357. DALE, H. & E., 26 Ludgate Hill, London, E.C.—Optical Scenic Lantern.

2358. KEEN, T. E., 14 Jesse Terrace, Reading.—The Cork and Wire Model Maker [a scientific toy].

2359. COX & YEMAN, 184 Brompton Road, London, S.W.—Improvements in the manufacture of billiard tables.

2360. BURROUGHS & WATTS, 19 Soho Square, London, W.—The Cottage Billiard and Dining Table.

2361. THURSTON & CO., 16 Catherine Street, Strand, London, W.C.—(1) Billiard Tables. (2) Billiard Room Furniture. (3) Patent Combination Billiard and Dining Table. (4) Model of Billiard Table with iron frame for adjusting slate bed. (5) Electric Marking Board. (6) Gas, Oil, and Electric Lighting for Billiard Tables. (7) Composition Billiard Balls. (8) Electric Billiard Cloth. (9) Specimens of Billiard Cushions, &c.

2362. ORME & SONS, Blackfriars Street, Manchester.—A Full-sized Billiard Table, fitted with Ball Tram and Galileo and other markers, patent rests, check marking boards, patent tips and tipping apparatus, cue racks, &c.

2363. MARSDEN & SAFFLEY, 9 & 11 Beacon Street, Liverpool.—Improved Billiard Table with patent dry bed which does not condense the atmosphere and render the cloth damp, therefore never requires hot-ironing.

2364. WRIGHT, G., & CO., 162 Westminster Bridge Road, London, S.E.—(1) The Neoteric Billiard and Dining Table

combined. (2) Improvements in Full-sized Billiard Tables. (3) The Eclipse Billiard Room Ventilator. (4) Composition Billiard Balls.

2365. REFFITT, J. W., Kirkstall Road, Leeds.—The Roller and Swivel Billiard Rest.

2367. CODNER, W. S., 83 Upper Thames Street, London, E.C.—Sockets for holding upright tent and lawn tennis poles, also for gate-post and telegraph pole basis. The same principle applied to tent pegs.

2368. SLAZENGER & SONS, 56 Cannon Street, London, E.C.—(1) Improvements in bats for lawn tennis and other games. (2) All recent improvements relating to lawn tennis. (3) Improvements in handles for bats and other analogous purposes.

2369. CARTER, JOHN, 8 Chippenham Terrace, Harrow Road, London, W.—Automatic Billiard and Pool Marking Board combined. Constructed to correctly register the number of points made at the game of billiards, and the number of slides [star slides included] drawn out at pool.

2370. HILLIARD, H., & SON, 7 Nicholson Street, Edinburgh.—Hilliard's Patent Skate.

2371. BEZER, HENRY, 12 Teddington Park Road, Teddington.—Improved Skate with adjustable foot-board to support the instep.

2372. TURNER, G., & CO., 181 Choumert Road, London, S.E.—(1) Improvements in wheel or roller skates. (2) Screw Pegs for lawn tennis poles, &c., for outdoor games.

2373. STRICKLAND, F. S., 7 Collingwood Terrace, Newcastle-on-Tyne.—Patent Lawn Tennis Signal Scorer.

2374. REMINGTON, ALFRED, 52 Southbrook Road, Lee; & BLUETT, ARTHUR COURTENEY, 8 Crown Terrace, Burnt Ash Lane, Lee, S.E.—An Improved Marker for lawn tennis and other games.

2375. TURNER, J., Twerton-on-Avon, Bath.—Turner's Lawn Skittles.

2376. BURGESS, WILLIAM, Berry Lodge, Malvern Wells, Worcestershire.—Various kinds of Humane Traps for catching rabbits, fish, &c.

2377. CANK, THOMAS, Hutton Hall, Preston, Lancashire.—(1) Alleviator, a means of curing gages in game and poultry. (2) Trap for capturing animals alive.

2378. SPONG & CO., 226 High Holborn, London, W.C.—Patent Improved Oar or Scull for rowing face to bow. Feathering self-acting. Great power, will fit on any boat. Weight 8 lbs. the scull.

BURTON, NATHANIEL, 16 Fentiman Road, South Lambeth, London, S.W. (*See Group VI.*)

GIBBONS, C. K., 27 Choppington Street, Newcastle-on-Tyne. (*See Group VI.*)

JOYCE, F., & CO., 57 Upper Thames Street, London, E.C. (*See Group XXV.*)

LAING, WILLIAM, 89 Whitburn Street, Sunderland. (*See Group XVII.*)

MORTON, JOHN, 223 Oxford Street, London, W. (*See Group XXIV.*)

NEWTON & CO., 3 Fleet Street, London, E.C. (*See Group XXVIII.*)

PATENT LIQUID FIRE-PROOF CYANITE PAINT CO., Limited (THE), 82 Bishopsgate Within, E.C., & Gunter Grove Works, Chelsea, London, S.W. (*See Group XIV.*)

PROPELLER BICYCLE & TRICYCLE CO. (THE), King Street Works, Coventry. (*See Group VI.*)

SALOMONS, SIR DAVID, Bart Broomhill, Tunbridge Wells. (*See Group XXVIII.*)

STEWART, JAMES HENRY, 46 Strand, London, W.C. (*See Group XXVII.*)

STORMONT, JAMES G., 112 Lion Street, Birmingham. (*See Group VI.*)

TODD & WRIGHT, 34 Craven Road, Hyde Park, London, W. (*See Group VI.*)

WALLACE, MAJOR N. W., 3 Eastern Villas, Southsea, Hants. (*See Group XXV.*)

WILKINS, T., 3 Meredith Street, Clerkenwell, London, E.C. (*See Group XXVI.*)

OUTSIDE.**SOUTH PROMENADE.****GROUP I.**

80. **DEACON, GEORGE, 103 Lower Thrift Street, Northampton.**—An Improved Method of Glazing without putty for horticultural buildings, railways, roofs, &c.

81. **SHEA, C. E., The Elms, Foots Cray, Kent.**—Improved Horticultural Frames and Lights.

82. **KENNEDY, WILLIAM, 70 Robertson Street, Glasgow.**—Translucent Plates or Sheets for use as substitutes for glass in roof-lights, suitable also for various ornamental purposes, such as painted window screens, &c.

83. **SARGENT, GEORGE, Ditton, Maidstone.**—Patent Continuous Fencing.

87. **SKINNER & BOARD, Horticultural Works, Stokes Croft, Bristol.**—Patent Venetian Fruit and Flower Houses.

88. **MONRO, JOHN, New Barnet, Herts.**—Glass Shelter Wall or Fence, convertible into pit or spawn-house, for getting the full advantage of the sun in ripening fruit-vines, espaliers, tomatoes, &c., in the open; for protection from wind, frost, hail, and sea spray; and for the earlier and better production of all kinds of vegetables, flowers and seeds.

90. **RENDLE, W. E., & CO., 8 Westminster Chambers, London, S.W.**—Original System of Glazing without putty.

92. **STEVENS, ROBERT, Horticultural Builder, Bromley, Kent.**—Patent three-bar system of glazing.

95. **DASHWOOD, A., & CO., 28 & 29 St. Swithin's Lane, London, E.C.**—Conservatory erected on their combination principle, the upper portion showing the adaptability of the shutter-bar system for large roofs, also a Greenhouse erected on their shutter-bar system of glazing.

96. **BARFORD & PERKINS, Queen Street Iron Works, Peterborough.**—Water Ballast Rollers for gardens, asphaltting, tennis and cricket grounds, field and estate purposes, and for road making.

97. **DEARDS, S., Horticultural Buildings, High Street, Harlow, Essex.**—(1) The Patent Victoria Dry Glazing:—One Large Conservatory; One Villa Conservatory; also Specimen of Victoria Dry Glazing, specially adapted for factories, shops, warehouses, &c., 50,000 feet of which have been used on the roofs of the International Invention

Exhibition Buildings. (2) Patent Close Coil Boilers, to heat from 200 to 1500 feet 4 in. pipe. (3) Patent Independent Coil Boilers. (4) The Princess Louise Coil Grate, specially made to heat conservatories from the ordinary fireplace.

98. **PINCHEN, JAMES, Hill View House, Market Lavington, Devizes.**—(1) Model of New Indestructible Exceller and Challenge Glass and Iron Roof Coverings. (2) Improved Greenhouse, &c., &c.

99. **FOSTER & PEARSON, Horticultural Builders, Beeston, near Nottingham.**—(1) Hot Water Horizontal Tubular Boiler to heat 2000 feet 4 in. pipe. Amateur's Boiler. Valves. (2) Span-roofed Moveable Frames. (3) Cucumber Frame. (4) Plant House. (5) Curvilinear-roofed Conservatory.

100. **MALET, O. W., Courtfield Gardens, South Kensington, London, S.W.** (Agents, **THE GLOBE ELECTRICAL AND ENGINEERING CO., 20 Dartmouth Street, Westminster, London, S.W.**)—F. Malet's Patent Solid Barbed Wire Fencing for Colonial use.

BRINDLEY, J., & CO., Limited, 67 King William Street, London, E.C.—Slate Silo.

BRITISH PATENT GLAZING CO. (THE), 24 Finsbury Circus, London, E.C.—Improvements in and relating to the glazing of roofs and other structures.

TROTMAN, JOHN, Rustic Works, 196 Holloway Road, London, N.—Specimens of Rustic Tables, Seats, Lawn Vans and Dog Houses. (*In Gardens.*)

GROUP II.

BATHO, W. F., 9 Victoria Chambers, Westminster, London, S.W.—The Batho System of Open Hearth Steel Melting Furnace.

GROUP III.

393. **CHIPPERFIELD, R., 26a Sekforde Street, Clerkenwell Green, London, E.C., Model Maker.**—Models of different inventions. (*See Building erected by British Patent Glazing Company.*)

394. **ANDERSON, G., & CO., Arbroath Foundry, Arbroath.**—Steam Derrick Crane, with steel ropes instead of chains.

395. **BATHO, W. F., 9 Victoria Chambers, Westminster, London, S.W.**—(1) Bruce & Batho's System of Excavating and Dredging. (2) The Batho System of Open Hearth Steel Melting Furnace.

396. **GEVEKE & CO.**, Amsterdam, Holland (Agents, **KUNSTER & RICARD**, 11 Queen Victoria Street, London, E.C.). — Geveke's Patent Tramway System.

397. **GRAFTON & CO.**, 113 Cannon Street, London, E.C. — Portable Steam Crane, Tilbury pattern, of two tons capacity, fitted with Patent Slewing Gear and Frictional Roller Path.

398. **LEGRAND, A.**, 18 rue Terre du Prince, Mons, Belgium. — Metallic Sleepers for railroads and tramways.

399. **STOTHERT & PITT, Limited**, Bath. — Wild's Patent Single-chain Dredger worked by Stothert and Pitt's Improved Horizontal Steam Crane.

400. **WILKES & CO.**, 17 Devonshire Square, Bishopsgate Street, London, E.C. — Norton's Patent Tramway Road Cleaner and Sander.

401. **WARNER, JOHN, & SONS**, Crescent Foundry, Cripplegate, London, E.C. — (1) Harrison's Patent Fog Bell Buoy Apparatus. (2) Goslin and Stoker's Patent Bell Buoys and Beacons.

IMPROVED WOOD PAVEMENT CO., Limited (THE), 46 Queen Victoria Street, London, E.C. — Improved Street Paving.

SACHUS, G. E., 3 Great Queen Street, London, S.W.; and **MAIGNEN, P. A.**, 32 St. Mary-at-Hill, London, E.C. — Localization and Filtration of Sewer Gas.

GROUP IV.

506. **BRITISH MÉKARSKI IMPROVED AIR-ENGINE CO.**, Limited (THE), 110 Cannon Street, London, E.C. — The Mékarski Improved Compound Air-Engines, for railway and tramway traction:— (1) Tramcar Engines—Joseph Clayton, Soho Foundry, Preston, Lancashire. (2) Tramcar Body—The Lancaster Wagon Co., Limited, Railway Carriage and Wagon Builders, Lancaster [W. C. Shackelford, Manager]; London Office, 1 Victoria Street, Westminster, S.W. (3) Air Compressing Machinery—The General Engine and Boiler Co., Hatcham Iron Works, Pomeroy Street, New Cross Road, London, S.E. (4) Permanent Way—The Denham-Olpherts-Molesworth system; Agents for Patentees, Messrs. Thomson & Browning, 3 Victoria Street, Westminster, S.W. (5) Electric Signalling Apparatus—Mr. J. A. Timmis, 2 Great George Street, Westminster, S.W. (6) Signals painted with the Patent Foo-Chow Enamels, which dry in three minutes, and are impervious to rain and atmospheric influences. —Donald Macpherson & Co., Knott Mill, Manchester; and 106 Cannon Street, London, E.C.

597. **DICK, KERR, & CO.**, 103 Leadenhall Street, London, E.C.; Brantanna Engineering Works, Kilmarlock. — Kerr's Patent Portable Railways.

598. **KERR, STUART, & CO.**, 2 Bucklersbury, London, E.C. — Appliances used in the construction of portable railway and light narrow gauge railways, rolling stock, locomotives, steam launches, tugs, and barges.

599. **SMITH, M. HOLROYD M.I.M.E.**, Halifax. — Electric Street Tramway as laid at Blackpool; various models of line and fittings.

GROUP V.

681. **AUTOMATIC APPARATUS CO.**, Limited (THE), 16 Rue Blaise, Paris (Agent, A. MACKIE, 19 Hop Exchange, London, S.E.) (COMPAGNIE DES APPAREILS AUTOMATIQUES POUR ACCROCHER LES WAGONS DE CHEMIN DE FER). — Apparatus for coupling and uncoupling railway carriages and trucks.

682. **TIMMIS, I. AUGUSTUS**, Great George Street, Westminster, London, S.W. — Improvements in Electric Magnets, working, locking and interlocking of Railway Signals and Points, and Railway Brakes.

683. **SOUTH - EASTERN RAILWAY GENERAL MANAGER'S OFFICE**, London Bridge Station, London, S.E. — Goods and Coal Wagon constructed so as to be run at express speed. (1) Is a wagon of the type now being built by the South-Eastern Railway Company at the Ashford Works for carrying goods and general merchandise at the maximum rate of speed. This wagon is furnished with wheels and axles similar to carriages, axle boxes for oil or grease, india-rubber buffer and draw springs, automatic coupling and safety chains. (2) Is another type of wagon built by the South-Eastern Railway Company to travel at maximum speed for the conveyance of coal or goods. This wagon is furnished in like manner to the last-named.

GROUP VII.

JESSOP, WILLIAM, & SONS, Limited, Brightside Works, Sheffield. — Full-sized Model of Patent combined Stern-post and Propeller Brackets for twin screw steamer, with solid rudder made in steel castings.

GROUP XXVIII.

2208. **ROYAL METEOROLOGICAL SOCIETY**, 30 Great George Street, S.W. (**WILLIAM MARRIOTT**, Assistant Secretary). — Typical Climatological Station of the Society. (East of Central Fountains.)

AMERICA, UNITED STATES OF.

WEST CENTRAL.

2501. **ALMOND, THOMAS R.**, Brooklyn, New York, U.S.A.—Angular coupling. (Group 12.)

2502. **CHASE, OLIVER R.**, 698 Washington Street, Boston, U.S.A.—Machine for moulding and shaping plastic material. (Group 17.)

2503. **RICKER, CARROLL L.**, 36 Columbia Heights, Brooklyn, New York, U.S.A.—Calorific's Positive Pump. (Group 3.)

2504. **FRENKEL, S.**, Behrenstrasse 1, Berlin (Agents, **ATKINS & HEBBET**, 1 Water Lane, Great Tower Street, London, E.C.).—Improvement in paving blocks. (Group 12.)

2505. **VANDERVELDE, M., & CO.**, Fard, Bavaria; and Waltham Building, Holborn Circus, London, E.C.—Improvements in the manufacture of celluloid. (Group 21.)

2506. **HUTCHINGS, GEORGE S.**, 38 South Howard Street, Baltimore, U.S.A.—(1) Can and Bottle Labelling. (2) Green Pea-shelling Machines. (3) Ash-sifters. (Group 17.)

2507. **BABSON, CHARLES, JUN.**, Congress Street, Boston, U.S.A.—Welding Apparatus for tin cans. (Group 10.)

2508. **GOLDSMITH, FERDINAND**, Winaw, Michigan, U.S.A.—(1) Automatic Coffee Roaster and Grinder. (2) Peanut Cutter and Corn Popper combined. (Group 10.)

2509. **HESHUYSEN, WILLIAM F.**, Mège, Belgium.—Rock-boring Machine. (Group 10.)

2510. **REID, SAMUEL**, 11, 13 South Canal Street, Chicago, U.S.A.—Lubricators for stationary, marine, and locomotive engines. (Group 3.)

2511. **ELBERS, ALEXANDER DANIEL**, 179 Hudson Street, Hoboken, New Jersey, U.S.A.—Treating fluid slag from iron ore smelting and blast furnaces. (Group 2.)

2512. **WING, LEVI J.**, 50 Cliff Street, New York, U.S.A.—Diso-fan or Exhauster. (Group 3.)

2513. **COWDREY FOUR-CYLINDER ENGINE CO. (THE)**, 163 & 165 Dearborn Street, Chicago, Illinois, U.S.A.—Steam Engine. (Group 4.)

2515. **BRITTON, JOSEPH W.**, 1516 Euclid Avenue, Cleveland, Ohio, U.S.A.—Straightening and Leveling Machine. (Group 10.)

2516. **GOLDING & CO.**, 143 Fort Hill Square, Boston, U.S.A.—(1) Chromatic, Job, and Tablet Printing Presses. (2) Improved Type Case. (Group 26.)

2517. **LAWRENCE & BAXTER**, 39 Dey Street, New York, U.S.A.; and 48 Farrington Street, E.C.—(1) Gally's Universal Press. (2) Paper Cutting Machine. (3) Royle's Routing Machine. (Group 26.)

2518. **DENISON MANUFACTURING CO.**, Boston, U.S.A.—Stationers' Specialities and Machines for the production of the same. (Group 26.)

2519. **LANCASTER, CHARLES**, 151 New Bond Street, London, W.—Gun and Rifle Making Machinery. (Group 25.)

2520. **HUNTER, ANDREW**, 42 South Clinton Street, Chicago, Ill., U.S.A. (Agents, **M. LYON & CO.**, 24 Mark Lane, London, E.C.).—(1) Middlings Purifier. (2) Centrifugal Reel. (3) Wheat Separator and Brush Scourer. (Group 17.)

2521. **AMERICAN WATCH CO. (THE)**, Waltham, Mass., U.S.A.; and Waltham Buildings, Holborn Circus, London, E.C.—(1) Machinery for making different parts of watches; male and female operatives at work. (2) Case containing all parts of watches. (3) Model of the factory. (4) Show Case with 1000 finished gold and silver watches. (Group 27.)

2522. **FISCHER, A.**, Casolinstrasse 20, Leipzig, Germany.—Improvements in wood-sawing machinery. (Group 10.)

2523. **SWEET, C. T., & CO.**, Cleveland, Ohio, U.S.A.—Automatic Sand Moulder. (Group 2.)

2524. **WARING, JOHN B.**, 22 New Church Street, New York, U.S.A.—Combined Centrifugal Pulverator, Concentrator, and Amalgamator. (Group 2.)

2525. **COMBINATION POWER PUNCH & EYELETING MACHINE CO. (THE)**, 49 High Street, Boston, Mass., U.S.A.—Combination Punching and Eyeleting Machine. (Group 18.)

2526. **KENT, G. B., & SONS**, 11 Great Marlborough Street, London, W.—Automatic Brush Boring Machine. (Group 22.)

2527. **RAPER, PEARSON & GILL**, Royal Victoria Place, Old Ford Road, London, E.—Automatic Brush Boring Machine. (Group 22.)

2528. ELECTRO-GRAPHIC MANUFACTURING CO. (THE), Mills Buildings, 23 Broad Street, New York, U.S.A.—Automatic Rapid Telegraphy.

(Group 13.)

2529. DAFT ELECTRIC LIGHT CO. (THE), 115 Broadway, New York, U.S.A.—Dynamo Electric Machine.

(Group 13.)

2530. FORT WAYNE JENNY ELECTRIC LIGHT CO., Fort Wayne, Allen County, Indiana, U.S.A.—(1) Electro Dynamo. (2) Lamps. (3) Cut-outs and General System of Air Lighting.

(Group 13.)

2531. REYNOLDS, F. W., & CO., Acorn Works, Edward Street, Blackfriars Road, London, S.E.—Wood Working Machines:—(1) Patent Combined Circular and Band Saw Sawing Machine for hand or steam power, The Queen, specially adapted for cross-cutting. (2) Improved Combined Self-Feeding Planing, Thicknessing, and Moulding Machine, to work, plane, or mould three sides, either separately or simultaneously. (3) Improved Planing, Moulding, and Trying-up Machine.

(Group 10.)

2532. CHASLES, H., 77 Rue de Montreuil, Paris.—Patent Ironing and Mangling Machines.

(Group 18.)

2533. TROY LAUNDRY MACHINERY CO., Limited (THE), Troy, New York, U.S.A. (Agents, **MATHER & ARMSTRONG**, 7 & 9 Grey Street, Newcastle-on-Tyne).—Washing, Centrifugal Hydro Extracting, Starching, Ironing, Mangling, and other Laundry Machinery.

(Group 18.)

2534. AUTOMATIC WEIGHING & PACKAGE FILLING MACHINE CO. (THE), 24 Hudson Street, New York, U.S.A. (Agents, **J. & M. COHEN**, 53 & 54 Houndsditch, London, E.C.).—Automatic Weighing and Package Filling Machine.

(Group 11.)

2535. BATEMAN, A., & CO., East Greenwich, London, S.E.—Drilling Machine.

2536. HARRISON, W., 10 Sussex Place, South Kensington, London, S.W.—Patent Shaving Brush.

(Group 1.)

2537. MYERS, F., 17 Ashcroft Buildings, Liverpool.—(1) Machine for Forming Barrels. (2) Machine for Nailing Boxes. (3) Machine for Printing Labels on Packing Cases.

2538. WALLEY & GARE, 6 Hopwood Avenue, Market Place, Manchester.—(1) Gare's Patent Paring, Burnishing and Finishing Machine for boot and shoe manufacturing and repairing. (2) Heel Tips. (3) Toe Tips. (4) Spikes for cricketing boots. (5) Waterproofing Solution for leather, paper, damp walls, plaster, cement, &c. (5) Rust-preventing Solution for bicycles, ironmongery, machinery, &c.

(Group 18.)

2539. DELARUE, MADAME JEANNE, 5 Passage Saulnier, Paris (Agents, **GARNIER & CO.**, 18 Queen Victoria Street, London, E.C.).—Machine for marble sculpture.

(Group 10.)

2540. PELTIER, E., & CO., 123 bis Route de Versailles & Ballincourt près Paris.—Machine for shelling peas.

(Group 17.)

2542. HURD, C. S., 176 Madison Avenue, New York, U.S.A.—Sackett's Plow and Pulverizer.

(Group 1.)

2543. ABC FENCE CO., 111 Broadway, New York, U.S.A.—Adams' Corrugated Metallic Picket Fence Machine.

(Group 1.)

2544. KINNEY, ISRAEL, Windsor, Ontario, Canada.—Sheet Metal Fabric.

(Group 3.)

2546. BABBOTT, WILLIAM M., 10-9th Street, Pittsburg, Pa., U.S.A.—Water Elevator and Purifier.

(Group 11.)

2547. ANDREWS, WILLIAM D., 283 Broadway, New York, U.S.A.—Improvements in the construction of wells or sunk reservoirs, and in means for procuring water therefrom.

(Group 3.)

2548. RIORDAN, T. VINCENT, 1 Whiteley Road, Upper Norwood, London, S.E.—Automatic Coupler for railway carriages, wagons, &c.

(Group 6.)

2549. BATLEY, JOHN, 4060 Girard Avenue, Philadelphia, U.S.A.—Improvements in traction locomotives.

(Group 6.)

2550. MCGILLIVRAY, JOSEPH, 904 Market Street, San Francisco, California, U.S.A.—Downie Eucalyptus Boiler Scale Preventive and Remover.

(Group 4.)

2551. BADGER, JONATHAN, Rockville, Centre, Long Island, U.S.A.—Window Ventilator.

(Group 3.)

2552. PARSONS, F. W., 1430 South Penn Square, Philadelphia, U.S.A.—G. H. Ame's Automatic Car Coupling.

(Group 5.)

2553. KEYSTONE SAFETY NUT LOCK CO., Lockbox, 1081 Philadelphia, U.S.A.—Keystone Safety Nut Lock.

(Group 5.)

2554. BARTON, CHARLES C., New York; and 48 Farringdon Street, London, E.C.—Water Meter.

(Group 3.)

2555. GRANT, JOTT, Boston; and 67 St. James's Street, London, W.—Improvements in Filters.

(Group 5.)

2556. GIBBON, THOMAS HENRY, ALBANY, Albany County, State of New York, U.S.A.—(1) Metal Sleeper and Chair Combination. (2) Automatic Railway Alarm Signal.

(Group 3.)

2557. **HARRIS, J. W.**, Boston, U.S.A. (Agent, **A. MACKIE**, 19 Hop Exchange, London, E.C.).—Clocks and Watches. (Group 27.)
2558. **LIVERMORE, C. W.**, Providence, U.S.A. (Agent, **C. VOIT**, 28 Bartlett's Buildings, Holborn Circus, London, E.C.).—The Livermore Stylographic Pen. (Group 26.)
2559. **BORNSTEIN, HENRY, & CO.**, 44 Hanover Street, Boston, U.S.A.—Patent Pin Hooks for tidies and pillow-shames. (Group 19.)
2560. **WARNER BROTHERS**, 353 Broadway, New York, U.S.A.—Coraline. (Group 9.)
2560. **ALEXANDER, MRS. ELIZA H.**, Box 10, Cornwall on Hudson, New York, U.S.A.—Machines for braiding and embroidering. (Group 18.)
2561. **FOXBORO MANUFACTURING CO.**, Foxboro, Mass., U.S.A.—Rotary Shuttle Sewing Machine. (Group 18.)
2562. **WARD, B. G.**, 2 West 14th Street, New York, U.S.A.; and 14 Newgate Street, London, E.C.—Rotary Treadle for sewing machines; no dead centres, and increased speed with less exertion. (Group 18.)
2563. **HARTMANN & BRAUM**, Frankfort (Agent, **Mr. C. ENGLISH**, 327 Vauxhall Bridge Road, S.W.).
2564. **LEVY SIGN CO. (THE)**, North West Corner, Fifth and Central Avenue, Cincinnati, U.S.A. (Agents, **JOSEPH, DAVIS & CO.**, 6 Kennington Park Road, London, S.E.).—Meteorological and other Instruments. (Group 28.)
2565. **WITTY & WYATT**, Billiter House, Billiter Street, London, E.C.—(1) Patent Improved Asbestos Roofing. (2) Smith's Patent Cetyddon Wire Fence. (Group 3.)
2566. **WETHERILL & BROTHER**, White Lead Works, Philadelphia, U.S.A.—Corroding House for the manufacture of white lead by the old Dutch process. (Group 3.)
2567. **LAW, VICTOR M.**, Cedar Rapids, Iowa, U.S.A.—Automatic Rapid Filter. (Group 28.)
2568. **SCHULZE, CHARLES T.**, 415 Vine Street, Cincinnati, Ohio, U.S.A.—Automatic Gate for elevator hatchways. (Group 3.)
2569. **LINDBLOM, CHARLES A.**, 323 East 105th Street, New York, U.S.A.—Railroad Cars, with radiating axles and independent wheel motion. (Group 5.)
2570. **KIRKWOOD, THOMAS**, 43 to 55 East Indiana Street, Chicago, Ill., U.S.A.—Furnace Grates. (Group 16.)
2572. **COPMAN, CHARLES**, 108 Avenue A, New York, U.S.A.—(1) Combination Nipple Holder and Adjustable Stock Revolving Gas Burners. (2) Direct Ventilating Fittings. (Group 3.)
2573. **NOBLES, JOHN C.**, Atlantic Highlands, Monmouth County, New Jersey, U.S.A.—Laundry Queen Bluer. (Group 14.)
2574. **RICHARDSON & LUSCOMB**, care of **J. J. MORRISON**, 383 Broadway, New York, U.S.A.—Washing Machine. (Group 18.)
2575. **NITSCH, O. R.**, 106 Bergmannstrasse, Berlin.—Improved Wringers. (Group 21.)
2576. **HARDWICK MANUFACTURING CO.**, Philadelphia, U.S.A.—Washing Machine. (Group 22.)
2577. **MILLAR, R.**, 29 Tichborne Street, Haymarket, London, W.—Flower Stall. (Group .)
2578. **KERR, EDWARD J.**, 1648 Magazine Street, 6th District, New Orleans, U.S.A.—(1) Field's Improved Adding and Counting Machine. (2) Improved Pruning, Paring, Coring and Slicing Knives. (3) Utilisation of Waste Materials. (Group 19.)
2579. **DI MARIANO & CO.**, 5 & 7 Maiden Lane, New York, U.S.A. (**A. HOND & CO.**, Osney Crescent, London, N.W.).—Gold and Silver Articles. (Group 19.)
2580. **YALE & TOWNE MANUFACTURING CO.**, Stamford, Conn., U.S.A.—Locks. (Group 24.)
2581. **SMEDES, LEVI K.**, per **TAYLOR & CO.**, 163 Bowery, New York, U.S.A. (Agents and Patentees for England, **SAHL & CO.**, 36 Bassinghall Street, London, E.C.).—(1) The Apex Folding Chair. (2) Patent Adjustable Pianoforte Chair. (3) Patent Triumph Hat and Coat Suspenders. (4) Triumph Folding Table. (Group 22.)
2582. **CUTTER, EPHRAIM**, 213 West 34th Street, New York, U.S.A.—Invalid Resting Chair. (Group 22.)
2583. **CUTLER & SON**, Buffalo, New York, U.S.A. (Agents, **WILLIAM ANGUS & CO.**, 66 & 68 Tabernacle Street, Finsbury, London, E.C.).—Office Desk and Chair. (Group 22.)
2584. **LADD, H. W.**, 134 Richmond Street, Boston, Mass., U.S.A. (Agents, **WILLIAM ANGUS & CO.**, 66 & 68 Tabernacle Street, Finsbury, London, E.C.).—(1) Solace Chair. (2) Folding Bed. (3) Braided Rocking Chairs. (Group 22.)

2585. LEWIS HAND FIRE EXTINGUISHER CO. (THE), 149 Broadway, New York, U.S.A.—The Lewis Hand Fire Extinguisher. (Group 11.)

2588. EASTMAN DRY PLATE AND FILM CO. (THE), Rochester, New York, U.S.A.—(1) Paper Dry Plates. (2) Photographic Films or Tissues and Apparatus for exposing same. (Group 29.)

2589. AMERICAN AUTOMATIC FIRE ALARM ASSOCIATION, 15 Simmon's Buildings, 40 Water Street, Boston, U.S.A.—Electro Thermostat. (Group 13.)

2590. IVES, F. E., 702 Chestnut Street, Philadelphia, U.S.A.—Process of Photo-Mechanical Engraving. (Group 29.)

2591. AMERICAN SCALE CO., Lynn, Mass., U.S.A.—Automatic Postal Scale. (Group 11.)

2592. HALL TYPE WRITER CO. (THE), 853 Broadway, New York, U.S.A. (Agents, WITHERBY & CO., 325a High Holborn, London, W.C.).—Type Writer. (Group 26.)

2593. COLUMBIA TYPE WRITER CO., 320 Broadway, New York, U.S.A.—Type Writer. (Group 26.)

2594. DOBSON, ALFRED J., 11 Charterhouse Street, London, E.C.—Mechanical Musical Top, playing airs whilst revolving. (Group 31.)

2595. FORCE, WILLIAM ARTHUR, 172 Fulton Street, New York, U.S.A.—(1) India-rubber Band Dating Stamp. (2) Inked Ribbon Stamp with Adamant Wheels. (3) Consecutive Automatic Duplicating and Repeating Machine. (Group 26.)

2596. HOWELL & JAMES, Limited, 5, 7, & 9 Regent Street; and 10 Charles Street, St. James', London, S.W.—Collection of Roumanian Embroideries and other examples of the peasant industries of Roumania. (Group 19.)

2597. NATIONAL CASH REGISTER CO. (THE), Dayton, Ohio, U.S.A.—Cash Register. (Group 28.)

2598. DELANY SYNCHRONOUS MULTIPLEX TELEGRAPH SYSTEM (THE), 84 Broad Street, New York City, U.S.A.—Illustration of the System. (Group 13.)

2599. BROOKS, JAMES, Broadway, New York, U.S.A. (Agents, A. HOND & CO., 15 Oseney Crescent, London, N.W.).—Gold in plates and Ornaments. (Group 19.)

2600. HENNING, GUSTAVUS C., 18 Cedar Street, New York, U.S.A.—(1) Self-centering Double Micrometer. (2) Modulus of Elasticity Machine. (3) Elastic Limit Indicator. (Group 3.)

2601. HOWARD & SON, Providence, U.S.A. (Agent, J. G. MOUL, 10 Cheniston Gardens, Kensington, London, W.).—Rolled Gold Jewellery. (Group 19.)

2602. GARDNER, G. H., & CO., 14 South William Street, New York, U.S.A.—Dry Agent Process of ice-making and refrigeration. (Group 17.)

2603. BLEVENEFY, JOHN C., Newark, State of New Jersey, U.S.A.—Friction Couplings and Clutches. (Group 4.)

2608. OTTINGER, DOUGLAS (Agent, R. F. GAGGIN, Erie, Pennsylvania, U.S.A.).—Life-saving Apparatus. (Group 14.)

2609. McADAMS, JOHN, & SONS, 528 Kent Avenue, Brooklyn, U.S.A.—Marine Brake. (Group 7.)

2610. CAMERON, J. F., 642 Lexington Avenue, New York, U.S.A. (Agent, G. M. DENNY, 5 Milk Street, London, E.C.).—Aerial Ship. (Group 8.)

2611. LORING, CHARLES THOMAS, 6 Bear's Buildings, Boston, U.S.A.—The Adjustable Telephone Support. (Group 13.)

2612. TAYLOR, T. F., 119 Albany Avenue, Brooklyn, U.S.A.—Improvement in Telephonic Receivers. (Group 13.)

2613. ATTIX, THOMAS F., 250 Broadway, New York, U.S.A.—The Electric Educator. (Group 20.)

2614. TELEMETER CO. (THE), Washington Buildings, Broadway, New York, U.S.A.—Telemetry. (Group 13.)

2615. YANDELL, CHARLES R., & CO., 6 East 18th Street, New York, U.S.A.—Leather Screens, Chairs, &c. (Group 20.)

2616. GUTEKUNST, F., 712 Arch Street, Philadelphia, U.S.A.—Phototype, or photograph in printer's ink. (Group 26.)

2617. OTIS, ANSON M., York, Nebraska, U.S.A.—Otis' Improved Charm. (Group 1.)

2618. DUNNING, JAMES, Bangor, Maine, U.S.A.—Watchman's Time Detector. (Group 27.)

2619. LUCAS, T., Farmhouse, Upper Edmonton, College Point, U.S.A.—Miner's Safety Lamp. (Group 2.)

2620. WHITE, J. CLAUDE, Swatara P.O., Schuylkill, Pennsylvania, U.S.A.—Traction Engine, with land ditching apparatus. (Group 1.)

2621. ANDERSON, J. H., Shelby, Polk County, Nebraska, U.S.A.—Hydraulic Dredges. (Group 6.)

2622. LANE SPRING HINGE MANUFACTURING CO. (THE), Asbury Park, New Jersey, U.S.A.—Samples of Hinges. (Group 24.)

2623. POLLOCK, JULIUS, 1069 Boston Avenue, New York, U.S.A.—(1) Improved Bleached Jute. (2) Imperishable Hydro-Carbon Writing Ink. (Group 9.)

2624. DICK, D., & CO., 112, 114 White Street, New York, U.S.A.—(1) Paper Package Wrapper. (2) Menthol Pencils or Cones. (3) Gelloid Empty Capsules. (Group 14.)

AUSTRIA-HUNGARY.

(Office of the Commission, Water Pavilion, Exhibition Buildings.)

GROUP III.

EBNER, JOSEF, 51 Clerkenwell Road, London, E.C.—Hungarian Parquet Flooring. Water Pavilion.

HOFF, PROFESSOR BOGDAN (Agent, F. KAROL & CO., 23 St. Martin's Lane, E.C.)—"Incomustable" Wood. Water Pavilion.

MITAR, D. CZVETKOVICZ, Esseg, Hungary.—Patent Automatic and Water Regulating Weir. No. 2701, East Central Gallery.

PIZZOLI, G., Lussing, Grande, Austria.—Intonaco, a new preparation of varnish.

RÜHR, FRANZ, Teplitz, Bohemia (Agent, JAMES PARIS, 50 Lime Street, E.C.)—Patent Blinds with metal mountings. No. East Central Gallery.

TRÄGNER, FERDINAND, Dreihunken, Austria.—Improved Material for roofing, made of wood, wire, and canvas. No. 2646 East Central Gallery. (See Group .)

GROUP IV.

SCHRABETZ, EMIL, Deutschmeister Platz 2, Vienna, 1 (Agent, JAMES PARIS, 50 Lime Street, E.C.)—Antifluctuator for Gas Meters. No. 80 East Central Gallery. (See Group XV.)

GROUP VIII.

MAYERHOFER, CHARLES ALBERT, Nussdorferstrasse 3, Vienna. (Agents, HARRIS & MILLS, 23 Southampton Buildings, W.C.)—A Military Telegraph Equipage, fitted with a balloon for reconnoitring the force and movements of the enemy. No. 32 East Central Gallery. (See Groups XI. & XIII.)

GROUP XI.

MAYERHOFER, CHARLES ALBERT, Nussdorferstrasse 3, Vienna (Agents, HARRIS & MILLS, 23 Southampton Buildings, W.C.)—Auto-Electric Safety Apparatus, in case of fire in theatres, &c. No. 32 East Central Gallery. (See Groups VIII. & XIII.)

MÖNCH, C. (Agents, F. KAROL & CO., 23 St. Martin's Lane, E.C.)—Fire Extinguisher without water. Water Pavilion.

GROUP XIII.

MAYERHOFER, CHARLES ALBERT, Nussdorferstrasse 3, Vienna (Agents, HARRIS & MILLS, 23 Southampton Buildings, W.C.)—Electro and Hydropneumatic Clocks and Apparatus. No. East Central Gallery. Electric Transmission for Railway and Telegraphs. (See Groups XIII. & XI.)

REBICEK, GUSTAV, Prague 251/L Bohemia.—Thermo-electric Batteries. No. 107 East Central Gallery.

STASICKI, K. (Agents, F. KAROL & CO., 23 Martin's Lane, E.C.)—Portable Electric Lamps. (Water Pavilion.)

WOLF, JOHANNES, Sxepes Igló, Hungary (Agent, L. A. GROTH, 30 Finsbury Pavement, E.C.)—Insulators and Poles. No. East Central Gallery.

GROUP XV.

SCHRABETZ, EMIL, Deutschmeister Platz 2, Vienna, 1 (Agent, JAMES PARIS, 50 Lime Street, London, E.C.)—Antifluctuator. No. East Central Gallery. (See Group IV.)

GROUP XVII.

TRÄGNER, FERDINAND, Dreihunken, Austria.—Refrigerator; can be used not only with ice, but also with water or air. No. 47 East Central Gallery. (See Group XXIII.)

GROUP XX.

GALDONYA, EUGENE, Budapest; and 33 Harrington Square, London, N.W.—Imitation of Leather.

GROUP XXII.

PORTOIS & FIX, Vienna.—Fancy Parlour Cabinets, walnut inlaid with porcelain. (Water Pavilion.)

GROUP XXIV.

PODANY, FRANZ, Hernals, Hauptstrasse 114, Vienna (Agent, **CHARLES LEHOFER**, 215 Long Lane, S.E.).—*Façonneur*, combined rasp and file for any material. No. East Central Gallery.

GROUP XXV.

AUSTRIAN MANUFACTORY OF ARMS, Steyr, Austria.—(1) Rifles (fifteen different patterns) as used in the continental armies. (2) Sword-bayonets to the above-mentioned systems.

GROUP XXVII.

MAYERHOFER, CHARLES ALBERT, Nussdorferstrasse 3, Vienna.—Pneumatic Clocks. No. East Central Gallery. (See Groups

GROUP XXVIII.

BERGER, DR. EMIL, Graz, Styria.—(1) Ceratoskop for astigmatism localisation. (2) A Ceratoskop, a new refraction ophthalmoscope. (3) Sketch of an automatic refraction ophthalmoscope with reversible intervals.

BUSCH & CO., Obere Donaustrasse, Vienna, II.—Cyclometer, geometrical instrument.

FISCHER & MIEG, Pirkenhausen, Austria.—China. (Water Pavilion.)

KNOLL, CARL, Fischau, Austria.—China. (Water Pavilion.)

WAHLISS, ERNST, Kärnthner Strasse 17, Vienna.—China and Pottery.

ZZOLNAY, WILHELM, Finkkirchen, Austria.—Falcon. (Water Pavilion.)

GROUP XXX.

DEUK, HANS, Vienna.—Deuk's Patent Cross-stick Print Machinery and Products. No. East Central Gallery.

DIVISION II.

FIEHN, H., Spenger Gasse 23, Vienna V.—Ocarina.

GLIER, GEBRÜDER, Markneunkirchen, Austria.—Violins and Zithers.

HOFMANN, Franzensgasse 23, Vienna (Agents, **SCHMEDES, ERBES LÖH & CO.**, 36 & 37 Monkwell Street, E.C.).—Pianofortes.

REBLICEK, G., Prague, Bohemia.—Musical Boxes.

SCHMIDT, HEINRICH, Garbergasse 195, Prag, Bohemia.—Tuning Lyra.

CHINA.

The Chinese Court has four shops, with beautifully carved fronts, from Peking; and outside the Court, there is a Chinese Restaurant and Tea House, with a large verandah overlooking the ornamental grounds.

Some idea of the exhibit may be formed from the following extract from Sir Robert Hart's memorandum, but the full details can be found in the Special Catalogue issued by the Chinese Commission.

China's co-operation to be illustrative of some of the more interesting features of Chinese life:—

- (a) Tientsin—to provide an Exhibit of all the grain and pulse in the northern market.
- (b) Hankow—to provide a shop for the sale of tobacco, pipes, &c., &c., &c.
- (c) Kiukiang—to provide a shop for the sale of porcelain, &c., &c., &c.
- (d) Canton—to provide a shop for the sale of miscellaneous articles, and also to supply a set of furniture for a Chinese *salon*, or reception room.
- (e) Ningpo—to supply a bedroom set of furniture, &c., and also patterns or samples of gauzes, grass cloth, &c., &c., &c.
- (f) Peking—to supply as follows:—
 - 1. A Chinese Restaurant (with all accessories).
 - 2. A Chinese string band (if possible).
 - 3. A shop to sell curios, &c., &c., &c.
 - 4. A set of lay figures, some 30 in all—dressed, to illustrate the dress of various classes of the Chinese in spring, summer, autumn, and winter.
 - 5. Mule cart or cab and harness; saddlery; a sedan chair; a wedding chair (with bride in dress worn day before, day of, and day after marriage); a mule litter; a Peking wheelbarrow; catafalque (model) and coffin; models of dwellings, monuments, &c., &c., &c.
 - 6. A Collection of Bows and Arrows, Swords, and Spears, &c., &c., &c.
 - 7. A Collection of Musical Instruments.
 - 8. A set of Stoves for use in house, in sedan, and in sleeve.
 - 9. Shop Fronts for the four shops.
 - 10. Specimens of Wood Panelling.
 - 11. Samples of Silks, &c.
- (g) Peking and Shanghai—to supply:—
 - 1. Books used by Chinese children.
 - 2. Books used by Chinese students.
 - 3. Books translated from foreign languages into Chinese to teach Western Science to Chinese, &c., &c., &c.
 - 4. Books prepared to enable Europeans to study Chinese.

J A P A N.

GROUP I.

Drawing of an Agricultural Carriage.

GROUP III.

Artificial Stone.

GROUP VII.

Boat Scull, with Tamura's latest improvements.

GROUP IX.

Raw Silk and Cocoons, Manufactured Silk, Linen, Carpets, Lace, Flags, &c.

GROUP XIII.

Telegraph Instrument, Magnets, &c.

GROUP XIV.

Medicine of various kinds.

GROUP XV.

(1) Porcelain Lamp Stand. (2) White Japanese Candles, best quality.

GROUP XVII.

(1) Japanese Tea of various kinds. (2) Soy and other Sauces. (3) Edible Roots. (4) Oil. (5) Mint Oil. (6) Preserved Fruits. (7) Japanese Cakes and Confectionery. (8) Japanese White Wine. (9) Cherry Blossom with salt. (10) Distilling Apparatus with accessories.

GROUP XVIII.

(1) Japanese Shoes. (2) Hat made of Bamboo. (3) Japanese Fans and Umbrellas.

GROUP XXII.

(1) Japanese Furniture. (2) Pictures. (3) Copper Flower Vases. (4) Sculptured Articles. (5) Book Cases. (6) Incense Box. (7) Artistic Door of old Japanese lacquer. (8) Tea Tray. (9) Screen decorated with velvet. (10) Lacquered Goods, &c.

GROUP XXIII.

Japanese Pottery:—(1) Jug of Satsuma Ware. (2) Tea Services, Porcelain. (3) Glass and Copper Bottles in Ornamented Case.

GROUP XXIV.

Surgical Instruments.

GROUP XXV.

Specimens of the Marata Gun.

GROUP XXVI.

(1) Japanese Papers. (2) Commercial Circulars. (3) *Shifuori* [a mixture of linen and paper]. (4) Samples of Type.

GROUP XXVIII.

(1) A *Kansuiki*, or pump. (2) Models of Instruments, &c. (3) Crucibles.

GROUP XXX.

Drawings of Insects.

GROUP XXXII.

Japanese Musical Instruments.

GROUP XXXIV.

MS. of Aino's Music.

R U S S I A.

GROUP I.

BACHAER,

—Hydro-incubator.

GRAPHITIO,

—Self-Acting Manure Spreader.

GROUP III.

FLAVITSKY,

—Ventilator.

LUBLINSKY,

—(1) Turned Parquet. (2) Improved Window Frames. (3) Newly-invented Rail, &c.

PROUSSAK,

—Hygienic Apparatus.

SCHMIDT,

—Cement.

GROUP IV.

NOVIKOFF,

—Boilers.

GROUP V.

TIMOFEEFF,

—Apparatus for heating railway carriages.

GROUP VII**HOTT,**

—Ropes.

MALCOLM,

—Hemp Yarn.

GROUP X.**BORISSOFF,**

—Machinery.

SESTRORETSK,

—Machinery.

TROUSCHKOVSKY,

—Machine with non-friction bearings.

WIEGAND,

—Machine.

GROUP XIII.**BOGUSKY,**

—Method of obtaining aluminium bronze by electricity.

DAVIDOFF,

—Electric Lighting Apparatus.

KOVAKO,

—Electric Apparatus.

SCHELIA,

—Electric Signal.

GROUP XIV.**BROCARD,**

—Perfumery.

PLATONOFF,

—Indestructible Enamel Composition.

OSSOVETSKY,

—Chemical Products.

GROUP XV.**ANDRÉE,**

—Illuminator.

ASTAFIEFF,

—Smoke Consuming Lamp.

CHIBAREFF,

—Mineral Oil.

NOVOSILSKY,

—Heavy Oils.

SCHAUDOR,

—Illuminator.

GROUP XVII.**JADOVSKY,**

—Cigarette Machine.

KRIGEMAN,

—Corks.

MAVROGORDATO,

—Cigarette Machine.

SERGUEÏEFF,

—Preparation of Sugar.

SOKOLOFF,

—Russian and Caucasian Wines.

GROUP XVIII.**GRÜN WALDT,**

—Furs.

HABALL, N.,

—Boots.

SIDEROFF,

—Silks.

GROUP XIX.**KLEBNIKOFF,**

—Silver Goods

GROUP XX.**BRONNITZENE,**

—Preparation of Leather.

HABNER, R.,

—Preparation of Leather.

KAHN,

—Packing Trunks.

NIESSEN,

—Preparation of Leather.

GROUP XXI.**KHARDINE,**

—Waterproof Stuffs.

GROUP XXII.**ABAZOFF,**

—Caucasian Manufactures.

KODJAION,

—Caucasian Manufactures.

MASIN,

—Apparatus for raising curtains.

MICHEL,

—Oil Cloth.

POSTNIKOFF,

—Bronzes.

REICHEL,

—Furniture.

TROUSOFF,

—Fancy Zinc Work.

WINKLER,

—Ornamental Iron Castings.

WOERFFEL (Agents, C.
ATKINS & NISBET, 1 Water Lane,
 Great Tower Street, London, E.C.)—

Stone and Bronze.

GROUP XXIII.**BOUROFF,**

—Pipes.

GROUP XXIV.**BANINE,**

—Improved Cutlery.

GROUP XXV.**MENKES,**

—Instruments of Precision.

GROUP XXIX.**BOLDIREFF,**

—Photographs.

SCHLUTZ,

—Improvements in Photographs.

DIVISION II.**GROUP XXXII.****ABAZOFF,**

—Musical Instruments.

ALBRECHT,

—Musical Instruments.

KOCH,

—Piano.

PETONKOFF,

—Musical Instruments.

SCHROEDER,

—Piano.

ZIMMERMANN,

—Musical Instruments.

SWITZERLAND.**GROUP XIV.**

GOEGG, G. (Member of the
 Geneva Botanical Society). — Chemical
 Analysis.

GROUP XVII.

DENNLER, A. F., Interlaken.
 (1) Swiss Alpine Bitters. (2) Iron Bitters.
NESTLÉ, H., Vevey (and at London).—Nestlé's Milk Food for infants and invalids.

LE COULTRE, , Geneva.—Mint, Cordial.

LAURENT & BAUVERD, Geneva.—Swiss Confectionery.

GROUP XVIII.

HAHN, , Geneva.—Apparatus for dress-cutting.

GROUP XIX.

HANTZ, GEORGE, Geneva.—
 (1) Works of Art. (2) Carved Chests. (3) Reproductions of Pictures on metal.

GAY, , Geneva.—Jewellery, Chains, and Bracelets.

LE GRAND ROY, Geneva.—
 (1) Genevan Enamelling. (2) Reproductions of Pictures.

DUFAURE, M., Geneva.—Enamelled Vases, Chests, &c.

COULIN, L., Geneva.—(1) Jewellery. (2) Speciality, Imitation of Alpine flowers.

GROUP XXII.

MÉRIENNE, F., Geneva.—Lackings.

STOERI & CO., Haetzingen.—Fancy Goods.

TOUSSERON, L., Geneva.—Patent Candlesticks.

MAUCHAIN, A. F., Geneva.—
 (1) Universal Desk for two persons. (2) Frames, Castors, &c.

GROUP XXIII.

FABRIQUE CÉRAMIQUE DE THOUNE, Thoune.—Imitations of Swiss Antique Pottery.

TRUFFET, MARC, Geneva.—
 (1) Artistic Pottery. (2) Works of Art.

GROUP XXVII.

BAUME & CO., 21 Hatton Garden, London, E.C. (and at Geneva, Les Bois, and Longines).—(1) Horizontal

and Lever Watches, both for keys and keyless. (2) Three-quarter plate Keyless Watches, adjusted for all climates. (3) Chronometers. (4) Repeating Watches. (5) The New Longines Watches and Chronometers.

CRANSAZ, PROFESSOR T., Horological School, Geneva.—(1) Balances for marine watches. (2) Watches.

DIACON, T. J., FILS, Terreaux de Chantepoulet 11, Geneva.—(1) Watches. (2) Repeating Watches. (3) Movements and Details.

GOY & BLANC, Geneva.—Improved Chronometers, marking one-fifth of a second.

L'HUILLIER, LÉON, Geneva.—(1) Watches. (2) Speciality in small watches for travelling.

PATEK, PHILIPPE & CO., Geneva.—Inventions and Improvements connected with watches and chronometers.

STAUFFER, SON, & CO., La Chaux de fonds.—(1) Watches and Chronometers. (2) Repeating Watches and other forms.

WEIDEMANN, , Geneva.—Watches, Chronometers, Movements and details.

GROUP XXVIII.

AMSLER-LAFFON, PROFESSOR T., Schaffhausen.—Planimeters and Integrators.

GROUP XXX.

LÜTHI, E., Bern.—School Table.

DIVISION II.**GROUP XXXII.**

HUNI & HUBERT, Zurich.—Invention for improving the tone of Pianos.

LANGDORFF & FILS, Geneva.—Musical Boxes.

PERRELET & CO., Geneva.—Musical Boxes.

PERRILAT, , Geneva.—Musical Boxes.

KARRER & WOHNLICH, Teufenthal.—Musical Boxes.

THE LANGHAM

The Table d'Hôte is Open to Non-Residents
from 6 p.m. to 8.30

PORTLAND PLACE, LONDON, W.

THIS COSMOPOLITAN HOTEL ACCOMMODATES 500 GUESTS

OTHER FOREIGN EXHIBITORS.

EAST CENTRAL GALLERY.

2632. **VON STEINAECKER, BARON F.**, Lauban, Silesia, Prussia.—Patent Governors. (Group 4.)

2633. **LINKE, R.**, Machine Building Institute, Freistadt, Silesia.—Patent Parallel Screw Driver. (Group 10.)

2634. **LEISTNER, CARL**, Leipzig.—Firing Iron, with moveable numbers. (Group 17.)

2635. **AGRATI, L. & CO.**, S. Pietro a Patierno, 11 via Casoria, Naples.—(Particulars Required.)

2636. **BAKKER, P. L.**, Everdingen, Netherlands.—Improved Sheave-making Machine. (Group 4.)

2637. **RASQUIN, ISIDORE**, Liège.—Driving Belts for engines. (Group 4.)

2638. **GREVEN, H.**, Naples.—(1) New Chamber Stove. (2) New and Economical Hygiene Carbons (Vegetable). (Group 16.)

2639. **ALMQVIST, FRIDOLF F^{son}**, Stockholm (Agent, L. A. GROTH, 30 Finsbury Pavement, London, E.C.).—Improved Apparatus for indicating and regulating the speed of engines. (Group 4.)

2640. **NORDENFELT, T.**, 53 Parliament Street, London, S.W.—New Method of Casting from wrought iron and steel. (Group 2.)

2642. **BLAY, E.**, 269 Rue St. Honoré, Paris (Agent, P. MITTON, 69 Oxford Street, London, W.).—Apparatus for Sup-
porting and Heating Dishes.

2643. **SACKUR, DR. H.**, Neander str. 86, Berlin (Agents, BECKMANN & CO., 4 South Street, Finsbury, E.C.).—Polishing Machine for nickelplated articles, &c. (Group 10.)

2644. **SCHNITZLEIN, F.**, Munich, Bavaria (Agent, L. A. GROTH, 30 Finsbury Pavement, London, E.C.).—Improved Safety Brake, for elevators or lifts. (Group 11.)

2645. **HEYLAND, MONSIEUR LE CHEVALIER**, Via Santa Radegonda 12, Milan.—Ball Filter with siphon. (Group 28.)

2646. **TRAGNER, F.**, Dreihunken, Austria.—Refrigerator. (Group 22.)

2646. **TRAGNER, F.**, Dreihunken, Austria.—Improvements in materials for roofing. (Group 3.)

2647. **POINSIGNON, JEAN BAPTISTE**, Rue Turbigo 14, Paris.—Cameo, in three colours, mounted in gold. (Group 19.)

2648. **PALMER FRÈRES**, 91 Rue d'Aboukir, Paris.—Iron Pottery. (Group 23.)

2649. **CONTI, ALFRED**, Via Cima-
bue 6, Florence.—Ceramic Art Reproduc-
tions. (Group 18.)

2650. **MONTEIRO, MARIANA**, 7 Hill Road, Abbey Road, London, N.W.—(1) Artistic Pottery [Portuguese]. (2) Figures [National Costumes]. (3) Caldas Ware. (4) Terra-Cotta Articles. (Group 23.)

2651. **SHANNON FILE CO.**, Berlin (Agents, P. & F. SCHÄFER, 1 Golden Square, London, W.).—The Shannonn File. (Group 26.)

2652. **VOSE, ROBERT**, Berlin (Agents, F. E. BECKER & CO., 34 Maiden Lane, Covent Garden, London, W.C.).—(1) Induction Electrical Machines. (2) New Improved Patent Hygrosopes. (Group 13.)

2653. **DANZIGER CELLULOSE FABRIK**, Dantsic (Agents, G. F. GREEN & CO., 3 George Yard, Lombard Street, London, E.C.).—Manufacture of Chemical Wood-pulp for paper-making, soda process. (Group 26.)

2654. **BADISCHE ANILIN AND SODA FABRIK (THE)**, Ludwigshafen on Rhine and Stuttgart (Agent, H. BECK, 22 Bush Lane, Cannon Street, London, E.C.).—Colouring matter and intermediate products or materials used in their manufacture from coal-tar. (Group 14.)

2655. **MEUNIER, E.**, 31 Rue Mau-
beuge, Paris (Agent, A. MACKIE, 19 Hop Exchange, London, S.E.).—Boots made with one piece of leather. (Group 18.)

2660. **BEAUME, W.**, Boulogne (care of P. MITTON, 69 Oxford Street, London, W.).—Patent Pumps for wine and beer. (Group 11.)

2661. **MAYRHOFER, C. A.**, 3 Nuss-
dorferstrasse, Vienna (Agents, HARRIS & MILLS, 23 Southampton Buildings, London, W.C.).—(1) Electric Transmissions for railway telegraphs. (2) Registering Apparatus. (3) Pneumatic Clocks. (4) Electro Clocks and Apparatus. (5) Pneumatic Tram-
way Motor. (6) Self-acting Air Compressor. (7) Pneumatic Voting Apparatus. (8) Obser-
vation Balloon. (9) Auto-Electric Safety Apparatus. (10) Correspondence Distributor. (Group 3.)

2662. **LEROY, CLAUDE NICOLAS**, 7 Rue Danton à Levallois-Perret.—Safety Apparatus to avoid railway accidents. (Group 5.)

2663. STOLLWERCK BROTHERS, Cologne.—(1) Chocolate Cooling Apparatus. (2) Patent Cocoa Roaster. (3) Machines for making lemonade and bonbons. (4) Patent Mixer and Grappled Boiler. (Group 17.)

2664. BUCKINGHAM & SONS, Rue Terre-Neuve, Brussels.—Fine Art Furniture. (Group 22.)

2665. IPSENS, P. ENKE, Copenhagen (Agents, **ARUP BROTHERS,** 120 New Bond Street, London, W.).—(1) Implements for manufacturing pottery and statuary in terra-cotta. (2) Products and Designs. (Group 23.)

2666. MADER, H., Isny, Württemberg (Agents, **ATKINS & NISBET,** 1 Water Lane, Gt. Tower Street, London, E.C.).—Patent Arrangement for changing dry plates. (Group 29.)

2667. MAGYAR & CO., Neu-Pest (Agents, **BUSCH & CO.,** 11 Ob. Donaustrasse 63, Vienna).—Cyclometer. (Group 18.)

2668. GRAFFY, A., & L. WADACK, Berlin; and 43 London Wall, London, E.C. (Agent, **A. WRESCHNER,** 43 London Wall, London, E.C.).—Universal Tele-meter. (Group 28.)

2669. DUVAL, ARTHUR, 11 Rue Recurt, Paris.—Improved Microscope. (Group 28.)

2670. BERGER, DR. E., 63 Glacisstrasse, Graz, Austria.—(1) Keratioskop. (2) Lokalisations. (3) New Refractions. (4) Ophthalmoskope, &c. (Group 28.)

2671. BOHRMANN, LEOPOLD, Berlin (Agent, **A. GUERLIN,** 23 Pelham Place, London, S.W.).—Microscopes. (Group 28.)

2674. AUBERLEU-OSTERLAG, F., Frankfort, Germany (Agent, **G. NEUMANN,** 10 Bull and Mouth Street, London, E.C.).—Coffee Machine. (Group 17.)

2675. SCHRABETZ, C., 2 Deutschmeisterplatz, Vienna.—Apparatus for preventing the unsteadiness of gas-light. (Group 4.)

2677. MENANT, P. H. J., Rue Pigalle 21, Paris.—New system for covering roofs with metallic tiles. (Group 3.)

2678. FROMM, T., 37 Langestrass, Frankfort, Germany.—Bilberry Wine. (Group 17.)

2679. WEINER, T., & SON, Vienna (Agent, **W. HIRSCHFELD,** 150 Osney Crescent, London, N.W.).—Preserved Pressed Yeast. (Group 17.)

2680. LIEBREICH, OSCAR, DR., Dorotheenstrasse, Berlin.—Improvement of bad tobacco. (Group 14.)

2681. ROTH, LUDWIG, Wetzelar, Germany (Agent, **CHARLES STROMEYER,** 45 Mildmay Chambers, London, E.C.).—Manufacture of cement from slag and raw or burnt lime, &c. (Group 3.)

2684. MERFELD, J. L., 7 Savoy Gardens, London, E.C.—Moss Litter. (Group 1.)

2685. SIMON, H., & CO., Hallesche Strasse 56, Berlin (Agent, **P. BORN,** 53 Queen's Road, Bayswater, W.).—Desks and Sample of an Oak Window with patent safety fasteners. (Group 24.)

2686. RUSCHEWEYH & SCHMIDT, Langenöls, Silesia, Germany (Agent, **P. BORN,** 53 Queen's Road, Bayswater, London, W.).—Patent Expanded Tables. (Group 24.)

2687. FRANCON, EMMANUEL, Rue de Provence, Paris; and Holm Elm, Wimbledon, Surrey.—(1) New System for inflating balloons. (2) Toys. (Group 24.)

2688. DRYER, ROSENKRANZ & DROOP, Manufacturers, Hanover (Agent, **P. BORN,** 53 Queen's Road, Bayswater, London, W.).—Manometers and Fittings for steam engines, &c. (Group 24.)

2689. REBICEK, GUSTAV, Prag, Austria.—Improvements in barometers and thermometers. (Group 24.)

2691. LUCKHARDT & ALTMANN, Cassel, Germany.—(1) Pantagraph. Precision Planimeter. (3) Linear Roll Planimeter. (4) Integrator. (5) Tachymeter. (6) Theodolite. (7) Levelling and Drawing Instrument. (8) Diapograph. (9) Mensural Powder Balance. (10) Densimeter. (11) Various Apparatus. (Group 24.)

2692. RÜHR, FRANZ, Teplitz, Bohemia, Austria.—Patent Spring Blinds. (Group 3.)

2693. COMPAGNIE FRANÇAISE DU CELLULOÏD, Paris and Stains (Agents, **C. ERHARDT & CO.,** 38 & 39 Brooke Street, Holborn, London, E.C.).—Celluloid and Chromolith. (Group 21.)

2694. TANI, VINCENZO, Piazza del Municipio, Naples.—Patent Dental Appliances. (Group 24.)

2695. ROLLA, C. G., 8 Piazza S. Nicolozio, Genova (Agent, **VINCENZO RIORDAN,** 1 Whiteley Road, Upper Norwood).—Regulator of very simple construction, enabling any one to vary the velocity of a machine without endangering the arm. (Group 3.)

2696. LAIRITZ, L. & E., Remda in Thüringen. — Anti-Gout Rheumatic Pine Woollen Clothing and Preparations.

(Group 19.)

2697. MULLER, T. H., Bilderdykstraat 1^{re}, Gravenhage, Netherlands. — Drawings and Plans of Steam Tramways.

(Group 3.)

2698. WILLS & SEGAR, Royal Exotic Nursery, Onslow Crescent, South Kensington, London, S.W.—(1) The Alexandræ Electric Bouquet. (2) Electric Coat Flower, and various other floral adornments for ladies and gentlemen, all illuminated by the electric light.

(Group 1.)

2699. VENICE & MURANO GLASS AND MOSAIC CO. (THE), Limited, 30 St. James's Street, London, S.W.—Venetian and Murano Glass and Venetian Enamel Mosaics.

(Group 23.)

2700. ROSEL, F., & A. BUIDANT, 16 Rue Neuve, Brussels; and 7 Mill Street, Hanover Square, London, W.—A Suite of Drawing Room Furniture with patent varnish.

(Group 22.)

2701. CHARELLI, J. A., & CO., 124 Rua Augusta, Lisbon; and 31 St. George's Place, Hyde Park Corner, London, W.—Ceramiques and Statuettes [Portuguese].

(Group 22.)

2701. MITAR, D., Czvetkovics in Basseg (Agents, BUSCH & CO., 11 Ob. Donaustasse 63, Vienna).—Patent Automatic and Water Regulating Weir.

(Group 3.)

2702. MONIER, JOSEPH, 191 Rue de la Pompe, Paris.—Iron and Cement Sleepers for railways and beam for bridges.

(Group 3.)

2703. DENK, HANS, 7 Goldschmiedgasse, Vienna (Agent, A. SANTI, 115 Strand, London, W.C.).—Patent Improved Cross-stitch Sewing Machine.

(Group 18.)

2704. FRITSCHÉ, GUSTAV, Scho-nau near Neutitschein, Moravia (Agent, P. BORN, 53 Queen's Road, Bayswater, London, W.).—(1) Improved Method of refining beetroot sugar-juice. (2) Specimen of a Forge and Blower.

(Group 17.)

2705. LEGRAND, J. SIMON, Bersée, Nord, France.—Apparatus for forcing or germinating grain, &c.

(Group 1.)

2705a. LIST, ADOLPH, 1 Platgwitzer Strasse 1, Leipzig.—Saccharine made from coal-tar.

(Group 17.)

2706. MAUL, W., Dresden (Agent, H. HUND, 128a Queen Victoria Street, London, E.C.).—Patent Envelope-making Machine, producing 1500 envelopes per hour.

(Group 26.)

2707. REGIDOR, MANUEL, Madrid; and 21 Billiter Street, London, E.C.—Improvements in Apparatus for distributing blast to blast furnaces and cupolas, &c.

(Group 2.)

2708. LANDRETH, C., & ISIDORO RENIS, Valencia, Spain (Agent, A. M. R. JURADO, 21 Billiter Street, London, E.C.).—Improved Apparatus for admitting and regulating the blast of air in cupolas and other similar melting or smelting furnaces.

(Group 2.)

2709. PIA, JOSEPH, 7 Rue Caillie, Paris (Agent, A. MAOKIE, 19 Hop Exchange, London, S.E.).—(1) Machine for filling and corking in one operation. (2) Patent Corkscrews. (3) Pneumatic Pump for transferring all kinds of liquids.

(Group 17.)

2710. PODANY, FRANZ, 114 Hauptstrasse, Hernals, Vienna (Agent, CARL LEHOFER, 40 Grange Road, Brompton, London, S.E.).—A tool replacing files and rasps, called Façonneur.

(Group 24.)

2711. FREEDE, LIEUT. C., The Hague, Netherlands.—Night and Fog Signalling Apparatus for the international signal book.

(Group 3.)

2712. HORSESHOE MANUFACTORY OF COPENHAGEN, Copenhagen, Denmark.—Horseshoes.

(Group 3.)

2713. LACOMBE, E. J. B., à Chatillon, Loiret, France.—Patent Preventive and Curative Pad.

(Group 6.)

2714. PARISE, ACHILLE, 100 Rue de Charonne, Paris.—Safety Locks.

(Group 24.)

2715. HOLLANDIA, FABRIQUE DE PRODUITS DE LAIT, Vlaardingen, Netherlands.—Preservation of Milk without sugar.

(Group 17.)

2716. JOACHIM, EMIL, Berlin, Ph.D., Works of Art Factory of Hamburg, Altona.—New method of producing a metallic lustre in majolica ware.

(Group 23.)

2717. GRACH, E. TRIER, Rhenish Prussia (Agent, P. BORN, 53 Queen's Road, Bayswater, London, W.).—Transparent Mosaic Painted and Stained Glass.

(Group 23.)

2718. DUVIGNEAU, O., & CO., Majolica Works, Magdeburg, Germany (Agents, THE GERMAN MAJOLICA CO., New Oxford Street, London, W.C.).—(1) Majolica Chimney Mantels. (2) Wall Decorations. (3) Tiles. (4) Pedestals. (5) Fountain and Artistic Pottery. (6) Closed Stoves.

(Group 23.)

2719. BRAUN, HENRY, 35 & 36 Rathbone Place, Oxford Street, London, W.C.; and 20 Rue Notre Dame des Victoires, Paris.—Fireproof China adapted to cooking utensils.

(Group 23.)

2720. SIEMENS, F., Glass Works, Dresden (Agents, J. BATT & CO., 39 Old Broad Street, London, E.C.).—(1) Hard Glass. (2) Cochrane's Patent Easy Opening Globe Stopped Bottle for aerated liquids. (Group 23.)

2721. BONNEFIS, L., Valence d'Agén (Agents, GARNER & CO., 18 Queen Victoria Street, London, E.C.).—Electro-Magnet with spherical centre for use in the construction of dynamos and electro-magnet machines. (Group 13.)

2722. WILDE, C., FILS & CO., 26 Rue Langier, Paris (Agents, GARNER & CO., 18 Queen Street, London, E.C.).—(1) Dynamo Machines. (2) Incandescent Lamps. (Group 16.)

2723. MAICHE, LOUIS, 3 Rue Louis-le-Grand, Paris.—(1) Telegraphic Appliances. (2) Reproduction of precious stones. (Group 13.)

2724. NORDENFELT, T., 53 Parliament Street, London, S.W.—Universal Dynamo Machines, invented by Mr. Jönsson, and made at Stockholm. (Group 13.)

2725. CLERC, LOUIS, 86 Avenue des Vernes, Paris.—(1) Electric Sun Lamp. (2) Clerc and Bureau's Dynamo. (Group 13.)

2726. PLANTE, G., 56 Rue des Tournelles, Paris.—(1) Electrical Appliances. (2) Galvanic Apparatus. (3) Engraving on Glass. (Group 13.)

2728. BARANY, A., & CO., 3 Rue Louis-le-Grand, Paris.—Electrical Apparatus. (Group 13.)

2729. WOLF, JOHANNES, Szepes Iglo, Hungary (Agent, L. A. GROTH, 30 Finsbury Pavement, London, E.C.).—Insulators and Poles. (Group 13.)

2730. CARETTE, G., 27 Boulevard de Courcelles, Paris.—(1) Electric Lamp. (2) Intensity and Potential Governor. (3) Mercury Brake. (4) Dynamo. (Group 13.)

2731. SAUZE, E., 48 Rue Folie Mercourt, Paris.—Inventions and Improvements in the manufacture of French clocks and timepieces since 1862. (Group 27.)

2732. ANTOINE FRÈRES, Besançon, France (Agents, HENRY JOHNSON & SONS, 39 Great Tower Street, London, E.C.).—Improved Keyless Watches. (Group 27.)

2733. MÜLLER, A. E., Schrottgasse 156, Passau, Bavaria.—Watches and Chronometers. (Group 27.)

2734. BEHA, J. B., & SÖNE, Eisenbach, Black Forest, Baden (Agents, CAMERER, KUSS, & CO., 56 New Oxford Street, London, W.C.).—Cuckoo Clocks. (Group 27.)

2735. CHRISTOPHERSEN, CHR, Christiania, Norway (Agents, AUGUST ZUMBECK & CO., 66 Mark Lane, London, E.C.).—Improvements in the string works of clocks. (Group 27.)

2736. MASETTI, BARTOLOME, Via Mazzini 71, Bologna, Italy.—(1) Electric Pile of great duration, for use in telephones and domestic electricity, such as bells, clocks, &c. (2) Table Pendulum Clock. (Group 27.)

2738. TURNER, R. B., 81 Rue de la Midi, Brussels; and The Hermitage, Andover Road, Newbury.—Daily Indicator. (Group 27.)

2739. RUNG, G., Copenhagen (Agents, SORENSSEN BROTHERS, 33 Great Tower Street, London, E.C.).—(1) Reautography. (2) Patent Rain Gauge. (3) Sinus Scales. (4) Automatic Cardiac Case. (5) Patent Self-registering Barometer. (Group 27.)

2740. SUTER, E., Basle, Switzerland (Agent, J. R. GÖTZ, 19 Buckingham Street, Strand, London, W.C.).—(1) Combinations of Lenses for photography, giving plane images with the full aperture. (2) High power Lenses for astronomy. (Group 27.)

2741. DOBBEL, JOHN, 52 Annenstraße, Berlin; and Savoy House, 115 Strand, London, W.C. (Agent, A. SANTI, 11 Strand, W.C.).—Fountains. (Group 13.)

2742. ADEMEK, ANTON, 12 Weingasse, Vienna (Agent, A. SANTI, 11 Strand, London, W.C.).—Perfumes, Soaps, &c. (Group 13.)

2743. CHERUBINI, CAV. CLAUDIO, MAJOR OF ARTILLERY, Piazza Solferino, Turin.—Geographical Wall Maps in Relief, for use in schools. (Group 3.)

2744. BOGGERO, C., Via Lentasio, Milan.—(1) Field Telephone or Alarm Telephone for telephonic and telegraphic correspondence. (2) Telephonic Bells. (3) Musical Acoustic Telegraph. (Group 13.)

2745. PIANESE, PROF. GENNARO, 8 Via Massena, Turin.—Talomero Pianese, an apparatus to measure the absorption of physis for bronchial and pulmonary diseases. (Group 23.)

2746. DE MARIA, CAPT. SALVATORE, Salita Pirozzoli 10, Naples.—New System of Propulsion and Steering of Ships, known as the Screw Rudder. (Group 7.)

2747. BIGNOLI, ENRICO, 3 Via Celsa, Rome.—New System of Stereotyping, and its new applications. (Group 23.)

2748. JACOBI, SAMUEL M., 61 Rue Dauphine, Paris; and 26 Limburg Road, Clapham Junction, London, S.W.—(1) Artistic Reproductions, as applied to chromo-typography, lithography, zincography, wood-engraving, &c. (2) Original

Drawings in water-colours and papier quadrille, adapted to the above printing processes.

(Group 26.)

2749. VIDAL, LÉON, 3 Rue Talma, Paris.—Photochromie. Improvements in photography as applied to decoration. (Group 29.)

2750. FUMAT, VICTOR, —, France (Agents, GARNIER & CO., 18 Queen Victoria Street, London, E.C.).—Patent Safety Mining Lamps. (Group 2.)

2751. ATTOUT-TAILFER, & J. CLAYTON, 63 Rue du Moulin de la Pointe, Paris.—(1) Gelatino-Bromide. (2) A frame containing a Model in Colours. (3) A Proof after our new process. (4) A Proof after the ordinary process. (Group 29.)

2752. JACOBI, S. M., 61 Rue Dauphine, Paris; and 26 Limburg Road, Clapham Junction, London, S.W.—Artistic Reproductions, as applied to Chromo-typography, Lithography, Zincography, Wood-engraving, &c. Original drawings in water colours and papier quadrille, adapted to the above printing processes. (Group 26.)

2753. GREVE, WILHELM, Berlin (Agent, WALTER KONSCHER, 43 Fish Street Hill, London, E.C.).—Litho-

graphy. Facsimile reproduction of water-colour drawings, geographical maps and plans, &c. (Group 26.)

2754. RECK, A. B., 155 Gothersgade, Copenhagen (Agents, CAPITO & HARDT, 23 Queen Anne's Gate, Westminster, London, S.W.).—Disinfecting and Drying Apparatus. (Group 3.)

2756. POLITI, ALESSANDRO, Via Carnevale 65, Girgenti, Sicily.—Photographic Camera. (Group 29.)

2758. ACHILLE, THOMAS, Nantes, France.—(1) Variable Proportional Scale. (2) Permutator for electric batteries. (3) Ellipsograph-Bisector. (4) The art of directing oneself at night time, teaching officers by a simple mechanical effect to direct themselves at night during a campaign. (Groups 3, 13, 30.)

2759. MOSCARELLO, PROF. GIUSEPPE, Largo Avellino 4, Naples.—(1) Four Strips on Tobler's system in wood or paper, each with five letters, for use in infant schools and elementary classes. (2) Farini's Cassettina with moveable letters, with twenty compartments to contain each ten copies of the same letter, with a desk. (3) Syllabarium for gradual reading. (Group 3)

DIVISION II.

MUSIC.

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DIVISION II.—MUSIC.

BY W. BARCLAY SQUIRE, B.A., CANTAB.

IN examining the orchestral scores of works composed at the beginning of the present century, there appears at first sight to be but little difference between the constitution of the orchestras for which they were written and of those of the present day. The Introduction to Haydn's 'Creation,' the first public performance of which took place on March 19, 1799, and which was heard in London in the year following, is scored for two trumpets, drums, three trombones, two clarionets, two horns, two oboes, two flutes, two bassoons, a double bassoon, first and second violins, viola, violoncello, and double basses, a combination which may still be taken as representing a normal full orchestra. Instruments such as the viol d'amore, the viol da gamba, the oboe d'amore, and the oboe da caccia, which are of not unfrequent occurrence in the scores of earlier masters, had by this time disappeared from the orchestra, and were as thoroughly obsolete, if not more so, than they are at the present day. It was with an orchestra constituted much the same as that used in Haydn's 'Creation' that the great masters who flourished in the latter half of the eighteenth century and the first thirty years of the nineteenth obtained all those surprising effects of instrumentation which modern audiences still admire, and it is such an orchestra—reinforced indeed by special instruments for obtaining special effects—which forms, so to say, the material which a modern composer has at his command. But though upon paper there appears to have been but little change in the constitution of the orchestra during the present century, yet the actual tone produced by the instruments

must, with almost the single exception of the string band, be very THE STRING BAND.
different now to what it was in the days of Haydn, Mozart, and

Beethoven. Instruments of the violin class, indeed, have undergone no material change, and though occasional would-be improvers have attempted to make alterations in the shape of the belly, back, and bridge, with the exceptions of a lengthened neck, reduced in size and set at a more acute angle, and the increase in size of the bass bar, necessitated by an altered manner of playing and a higher pitch, the repeated failure of these efforts shows that the form of these instruments must be regarded as definitely settled. The best violins made now are those which most closely conform to the instruments made by Antonio Stradivari at Cremona more than 150 years ago. On the other hand, in no instrument in the orchestra has there been more change made than in the flute, which from being one of the most imperfectly constructed of wind instruments, has become almost the only one to which scientific principles

have been rigorously applied. The flutes in use at the beginning of the THE FLUTE.
present century were usually made with four, and occasionally with six,

seven, or even eight keys—the latter number being that adopted generally in instruments of this class at the time of Boehm's improvements—and the holes were placed without regard to the proper theoretical position for the production of the notes, but simply wherever was most convenient for the fingering. The keys themselves were generally square, and covered with leather pads, the notes were not properly vented, and the instrument, as was only to be expected, was not only very difficult to play in tune, but very deficient and unequal in tone and power. The alterations which Theobald Boehm introduced were founded on the principles that the holes should be as nearly as possible equal in size and that the keys when in repose should be open instead of closed. To these improvements were added the adoption of a new bore, in which the body and foot are cylindrical, while the head-joint is in the form of a truncated cone, by means of which a distinctly different quality of tone is imparted to the instrument. The alteration effected by placing the holes in their theoretically correct positions entailed a change in the fingering, and the keys, instead of being fixed on wooden supports, are now mounted on cylindrical tubing supported by small pillars with a complex action in order to bring them under the fingers, whilst the proper venting of every note is secured by the keys over the hole below the one giving the note being left open. The old conical flute is still retained in military bands, but the much more perfect instrument described above is now in general use.

In another class of wind instruments, viz. those in which a column of air is set in vibration by means of a reed, the improvements effected during the present century have not been of so marked a character as those which have taken place in flutes. The oboe, a descendant of the mediæval discant schalmey, was

THE OBOE.

first used as such in the orchestra of the Paris Opera in 1671; but at this time it was constructed without keys. In 1825, according to a method published at that date in Vienna, the keys were nine in number, besides one to facilitate the production of sounds in the octave higher. Triebert, of Paris, and others, have attempted to apply to these instruments Boehm's system of placing the holes in their proper theoretical position, but it has been found that this alteration so changed the character of the tone as to render the improvement dubious and unacceptable. But though the oboe still continues in this respect to be constructed on empirical principles, it has during the last half century been the subject of many improvements in the mechanism of the keys, rendering it now an extremely complicated and elaborate instrument. Similarly the bassoon, which may

THE BASSOON.

be regarded as a bass oboe, has been much modified by recent makers, most of whom are French or German, though in the case of this instrument the differences in construction and method of the keys and fingerings are so various that no settled model of it may be said to exist. The cor anglais, which is

THE COR ANGLAIS.

virtually a tenor oboe, has followed the oboe in improvement. It was used by Gluck in Vienna in 1767, but was not heard in Paris until 1808, since when it has become of frequent use for the production of particular effects. The

THE CLARINET.

clarinet, which differs from the oboe in the column of air being set in vibration by means of a single, instead of a double reed, is an instrument of comparatively recent adoption in the orchestra, having first been used to any great extent by Mozart, and so late as the year 1791 was constructed with only six keys. In 1810 seven more were added by Iwan Müller, since when the improvements it has undergone have been more or less experimental in character. In 1842 Boehm's system of movable rings was applied by a Parisian maker, Buffet, but the older form of the instrument is still that which is generally in use, the application of Boehm's invention being considered to be of too elaborate a nature, and rendering the mechanism very complicated. Other instruments of the clarinet family which are used in modern orchestras are the

THE BASSET-HORN.

basset-horn, now modified into and superseded by the alto clarinet and bass clarinet, an instrument which, though made in Dresden in 1793, was much improved by Sax, and first used in the orchestra by Meyerbeer in 1836, when it appeared in the score of 'Les Huguenots.' The mention of Sax's name naturally leads to some reference to the remarkable series of inventions made by that ingenious family, and more particularly by its chief

member, Adolphe. Although the instruments which bear his name are not in much use in English orchestras, they have been very generally adopted in military bands, and occasionally have found their way into the scores of distinguished composers, such as Berlioz, Meyerbeer, and Ambrose Thomas, all of whom have made use of saxhorns and saxophones. The latter may be regarded as forming an intermediate class between the oboe and the clarinet families, the brass tube of which they consist being conical as in the oboe, but the column of air in it being set in vibration by a single reed, as in the clarinet.

In examining the changes that have taken place in the class of instruments in which the air column is set in vibration by the lips applied to the cup-shaped extremity of the tube, to which class most brass instruments, commonly so called, belong, it will be well to note that originally the three principal instruments of this class, i.e. the bugle, the trumpet, and the French horn, only produced the fundamental notes and their respective harmonics, and consequently the object of successive inventors has been so to alter them as to obtain a perfect chromatic scale. The alterations that have taken place in these instruments consist in the successive introduction of keys and pistons or valves, of both of which some notice will be found farther on. Another division of this group is that of the trombone, in which, by lengthening the column of air by means of a slide, or by the modern introduction of pistons, a succession of fundamentals and

THE BUGLE, TRUMPET,
FRENCH HORN, TROM-
BONE, SERPENT, & OPHI-
CLEIDE.

harmonies is obtained. Coming to the application of keys to this group, the serpent must be regarded as the oldest example of its class, but although it occurs in the scores of Mendelssohn, Auber, Rossini, and Wagner, it is now practically obsolete. The keyed bugle, long known in England as the Kent bugle (owing to its having been a favourite instrument of the Duke of Kent's), was patented in 1810 by Joseph Halliday, a bandmaster in the Cavan Militia, and the principle upon which it was constructed was soon adapted to other instruments. The chief of these was the ophicleide, which was introduced in 1817, and was the heaviest bass instrument in use in military bands until about 1850, when it began to be replaced by the euphonium and bombardon, valve instruments, and the only saxhorns used to any extent in orchestras, although in military bands they have been universally adopted. But the use of all keyed instruments has now been superseded by the invention (in 1815), by H. Stöelzel, of the piston valve, and of the cylinder valve, its German substitute. This was an application of the trombone principle of altering the length of the column of air by lengthening the tube, instead of by shortening it by lateral openings as had been done in keyed instruments. It was first applied to the horn, but is now general in all this group, and by means of it a succession of instruments is in use, which, from the first soprano cornet to the bombardon, covers a range of about five octaves. Since the adoption of valves or pistons many inventions have been made in order to equalize the air passages and to make the scale correct in pitch and uniform in quality, these being the two great points in which the system is still deficient.

THE EUPHONIUM AND
BOMBARDON.

Any review of the principal changes which have taken place during the nineteenth century in the chief orchestral instruments would be incomplete without some reference to the harp and the drums, in both of which considerable improvements have been introduced. The former instrument was early in the century entirely remodelled by Sebastian Erard, so that tuned in C flat and raised chromatically by an ingenious double movement of the pedals, seven in number, it can be played upon in any key; while the drums can now, by means of handles acting on the ring enclosing the parchment, be tuned by two or even one handle in the most rapid way, thus enabling them to be played in many more keys than the old system of tonic and dominant tuning allowed.

THE HARP.

THE DRUMS.

Having now briefly reviewed the chief alterations which the principal orchestral instruments have undergone in the course of the century, it remains only to notice some of the chief improvements which have taken place in the keyboard instruments, the pianoforte, the organ, and the harmonium. At the beginning of the century the former instrument, although it had already been considerably modified, retained many of the features of its immediate predecessor the harpsichord. In particular, its construction was entirely of wood;

THE PIANOFORTE.

and the mechanism and strings such as a modern pianist would break in half an hour's playing. Its tone, possessing a peculiar sweetness and charm, was totally distinct from that of the modern instrument, and has been so changed as to produce such a volume of sound that it is almost impossible now to realize the effects intended in early chamber music in which it was employed. The great change of the century in the instrument has been the gradual displacement of wood by iron, the first credit of which is due to William Allen, who (in conjunction with James Thom) took out a patent on 15th January, 1820, to counteract the tendency of pianofortes to get out of tune by a compensatory system of brass and iron plates and tubes, the latter acting as resistance bars. The principle of this invention was soon adopted for resistance by the chief makers, its utility being recognised as allowing the employment of much heavier strings and a consequent increased tension. Allen's metal tubes were soon replaced by solid tension bars. In 1824 Erard was using a complete system of them; in 1827, Broadwood patented the metal string plate in combination with them; and in 1847, the same firm made the first grand piano with diagonal barring and a complete wrought-iron frame, adding, in 1862, an iron wrest pin-piece. Two other inventions have had an important influence in the construction of modern pianos—(1) The system of cross- or over-stringing, which was invented by Theobald Boehm in 1831, though not brought prominently into notice in England before the Great Exhibition of 1851; and (2) the construction of the frame of the instrument in a single iron casting, which was practically effected in America about 1833 by a German named Conrad Meyer, and was afterwards improved and developed by

Chickering of Boston. These inventions were combined by Steinway of New York in 1859, and have been largely adopted by American and German makers, both for grand and upright pianos. The tension of grand pianos made on this system reaches the enormous strain of at least 25 tons. Limits of space preclude more than a passing reference to inventions in pianoforte actions, of which those of Wornum and Erard in the present century have been the chief. The upright pianoforte, in its modern form, is one of the most important descendants of the old harpsichord which has been developed during the present century. It was invented by John Isaac Hawkins an Englishman resident for a time at Philadelphia, U.S.A., who patented it in England on 13th November, 1800, but was rapidly improved by different makers, and the same principles as already mentioned, were applied to it as to the grand piano. Hawkins should have the credit of being the inventor of the iron piano frame. With regard to the

THE ORGAN.

organ, the alterations in its structure may be briefly summarized as follows:—(1) Methods of lightening the touch, either by applying pneumatic or electric action; (2) inventions to regulate the various pressures of wind on the different registers; (3) improvements in the harmonic stops; (4) the introduction of the pneumatic tubular transmission system (which is simply a long tube with valves at one end, through which compressed air is admitted, raising a loose membrane at the other end, and thus enabling an organ to be played at a long distance from the keyboard); and (5) improvements in the blowing apparatus, by which water or gas is employed as the motive power instead of manual labour. The remarkable improvements in the class of free reed keyboard instruments known as harmoniums and American organs must be dismissed in a few words; both these instruments are virtually inventions of the

THE HARMONIUM AND AMERICAN ORGAN.

present century. The harmonium was completed as an invention by Debain, a Frenchman, in 1840; but the expression, which permits varying intensities of sound, was subsequently added by Alexandre. The now popular American organ, in which the wind is sucked instead of blown, was introduced by Mason and Hamlin of Boston, U.S.A., about the year 1860.

In conclusion, a few words must be said about the engraving and printing of music during the 19th century. With regard to the latter, the improvements in printing music from movable types have been very much the same as those in ordinary printing. The types are set up separately and stereotyped, after which the slurs and ties are put in and the plate is printed. Corrections having to be made by cutting out the mistakes from the stereotyped plate. The system is employed very largely in England for the production of cheap editions of works which have a considerable sale, but abroad it is almost entirely confined to publications in which musical examples are required in a large body of letter-press. The engraving of musical plates has, on the other hand, until within the last few years, been carried to a greater degree of perfection on the Continent than with us. The English system consists in engraving the music on the pewter plate directly from the manuscript, after which the plate is sent back to the pewterer to be "beaten," i.e. to have all the irregularities removed from the surface before it is transferred to the stone. In Germany, on the other hand, more attention is paid to appearance and regularity, and also to the elegant shapes given to the notes and rests. Another advantage of the German system is that the workmen beat their own plates. This system was introduced by German workmen about twenty years ago, and though it demands more skilled labour than the English method of engraving, the results it produces are infinitely superior, and its general adoption can only be a matter of time. The plates are transferred to lithographic stones, from which the printing is done on paper, by means of litho-printing machines, for which steam has only been used comparatively recently. Fine editions, such as those of the Handel and Bach Societies abroad, or the Purcell Society in England, are printed directly from the plates.

MUSIC ENGRAVING AND PRINTING.

GROUP XXXII.—INSTRUMENTS AND APPLIANCES CONSTRUCTED OR IN USE SINCE 1800.

3501. **WILLIS, HENRY, & SONS**, Rotunda Organ Works, Camden Town, London, N.W.—(1) Patent Organ. (2) Electric and Pneumatic. (3) Grand Blowing Apparatus. (4) Improvements in the pneumatic lever.

3502. **BAILEY, W. H., & CO.**, Albion Works, Salford, Manchester.—Bailey's Patent Organ Blower, blowing the bellows of the organ exhibited by Messrs. Bishop & Sons.

3503. **BISHOP & SON**, 250 Marylebone Road, London, N.W.—Church Organ with separate console on Bishop's tubular pneumatic system, combining in one instrument the advantages of the philharmonic and normal pitches.

3504. **JONES, HENRY, & SONS**, 136 Fulham Road, South Kensington, London, S.W.—Church Organ, with three manuals and thirty-seven stops. It has a remarkably light touch without pneumatic action, and a newly invented combination movement.

3505. **WEDLAKE, HENRY, & BARKLEY**, 92 stops, Wedlake's new patent pneumatic. Wind supplied to this model by Wedlake's improved double-action feeders. Wedlake's new patent pneumatic pedal attachment to pianos.

3506. **BAMFORD, HENRY**, 18 White Lion Street, Pentonville, London, N.—Patent Gunmetal Hydraulic Organ-Blower. Exhibited in actual work, blowing four-manual organ, by Messrs. J. W. Walker & Son.

3507. **WALKER, J. W., & SONS**, 27 Francis Street, Tottenham Court Road, London, W.C.—Church Organ of 4 rows of keys, with improved pneumatic, electro-pneumatic and tubular-pneumatic actions, hydraulic gas-engine blowing apparatus, the fourth row of solo-swell organ being entirely acted upon at a distance by the electric current.

3508. **BRINDLEY & FOSTER**, Suffolk Road, Sheffield.—Model great organ of twelve speaking stops [one manual and pedal], showing application of new tubular pneumatic action, with improved pneumatic couplers.

3509. **MASON & HAMLIN ORGAN AND PIANO CO. (THE)**, Boston, U.S.A. (Agents **METZLER & CO.**, 42 Great Marlborough Street, London, W.).—(1) American Cabinet Organs. (2) Reed Organ blown by water-power. (3) Upright Piano. New system of stringing.

3508. **FARMER, M.**, 34 & 38 Britten Street, Chelsea, London, S.W.—Automatic Musical Instruments and Machines for making paper bellows for same, and for cameras, &c.

3509. **LACHENAL & CO.**, Little James Street, Gray's Inn Road, London, W.C.—Patent English and Duet Concertinas, also Anglo-German.

3510. **MACCAM, J. H.**, 80 Morley Street, Plymouth.—The New Patent Duet Concertinas.

3511. **PICHLER, S. FRANCIS**, 162 Great Portland Street, London, W.—(1) Harp and Lyre Concertinas. (2) Atmospheric Percussion Harmonium.

3512. **WHEATSTONE & CO.**, 20 Conduit Street, Regent Street, London, W.—Concertinas.

3513. **HERMANN, JAMES**, 12 Edward Street, Hampstead Road, London, N.W.—(1) Concertinas. (2) Accordions. (3) Reeds and Air Channels.

3515. **ESTEY ORGAN CO.**, 42 Holborn Viaduct, London, E.C.—American Organs and Pianos.

3516. **MURDOCK, JOHN G., & CO., Limited**, 91 and 93 Farringdon Street, London, E.C.—American Organs, Piano-fortes, Harmoniums, and Automatic Instruments.

3517. **SCANTLEBURY, WM.**, 15 Lea Bridge Road, London, E.—Harmonium with resonant chamber and octave coupler, made and patented by exhibitor.

3518. **FORSYTH BROS.**, 122 & 124 Deansgate, Manchester; and 272a Regent Circus, Oxford Street, London, W.—Dominion Organs.

3519. **BROWN, COLIN**, Anderson's College, Glasgow.—(1) Monopolytone. (2) Voice Harmonium with eight digitals only in each octave, and fingering the same in all keys of the scale.

3520. **CLOUGH & WARREN ORGAN COMPANY**, Detroit, Michigan, U.S.A. (Agents, **CHAPPELL & CO.**, 50 New Bond Street, London, W.).—Combination Organs.

3521. **COUSINS, GEORGE**, Birchington-on-Sea, near Margate, Kent.—Harmonium, showing method of tuning reeds of same so that it can easily and quickly be tuned to the same pitch as any instrument it might be desirable to use with it.

3522. **HAHN, KARL**, Neumeyer Hall, Hart Street, London, W.C.—The Cantus Transcendentalis.

3523. **DESOIZE, O.**, 23 Berners Mews, Middlesex Hospital, London, W.—Organ.

3524. GILDERSLEEVE, JOSEPH, & CO., 20 Torbay Street, Hawley Road, Kentish Town, London, N.W.—Organ Pipes.

3525. WILKINSON & SONS, Northern Counties Organ Manufactory, Kendal.—Patent Adjustable Composition Action, Check Swell Pedal, and Anti-Friction Blowing Apparatus.

3526. JONES, WM. C., 24 Duke Street, Chester.—Spring Concertina or Monophone for giving key tones.

3527. WELTE, M., & SÖHNE, Freiburg in Baden, Germany.—Electric Organ.

3528. JONES, THOMAS S., Church Organ Works, Pentonville Road, Islington, London, N.—New Improved Model Village Church Organ.

3529. BARNETT SAMUEL & SONS, 26 & 32 Worship Street, London, E.C. Harmoniums.

3530. MUNROE ORGAN REED CO. (THE), Worcester, Mass., U.S.A. (Agents, C. ERHARDT & CO., 38 & 39 Brooke Street, Holborn, London, E.C.).—Reeds and Fittings for American Organs.

3531. GERN, A., Boundary Road, Notting Hill, London, W.—

3532. PELOUBET & CO., Bloomfield, New Jersey, U.S.A. (Agents, BARNETT SAMUEL & SONS, 26 & 32 Worship Street, London, E.C.).—American Organs.

3533. FISCHER & FRITSCH, Leipzig (Agents, SCHMEDEES, ESBSLOH, & CO., 36 & 37 Monkwell Street, London, E.C.).—Adiaphone.

3534. MACHELL, THOMAS, 35 & 39 Great Western Road, Glasgow.—Patent Novel Musical Instrument, the tones of which are produced from forks of steel connected with a soundboard, and actuated by keys, hammers, and pedal, as in the pianoforte; also an adaptation of the above in portable form.

3535. PARR, E., 16 Long Lane, Aldersgate Street, London, E.C.—American Organs.

3536. JONES & CO., 21 & 22 Bridge Street; and Bristol Organ Works, Bristol.—(1) Patent Combination Bristol Organ, with two manuals, 24 stops, having the exhaust or American system on the upper manual and the pressure or harmonium system on the lower manual. (2) Double Manual Bristol Organ, having the exhaust system on the lower manual with solo expression organ on the upper manual, and patent blowing arrangements. (3) Bristol Organ, illustrating several recent improvements. (4) Patent Folding and Adjustable Organ Seat.

3537. STEVENS, RICHARD F., 343 Euston Road, Fitzroy Square, London, W.—(1) American Organ. (2) Harmonium.

3538. BRIDGEPORT ORGAN CO., Bridgeport, Conn., U.S.A.—American Organs.

3539. KEITH, PROWSE, & CO., 48 Cheapside, London, E.C.—(1) Harmoniums. (2) Concertinas. (3) Accordions. (4) Wood and Brass Wind Orchestral Instruments. (5) Pianofortes. (6) Violins. (7) Automatic and Barrel Instruments. (8) Drums. (9) Pitch Pipes, Tuning Forks, Metronomes. Deaks, Seats, &c.

3540. WORCESTER ORGAN CO., Worcester, Mass., U.S.A.—(1) Reed Organs. (2) Two and Single Manual Church Organs. (3) Parlour Organs, single manual.

3541. SMITH AMERICAN ORGAN CO. (THE), Boston, Mass., U.S.A.; and 59 Holborn Viaduct, London, E.C.—Organs.

3542. MECHANICAL ORGUNETTE CO. (THE), 831 Broadway, New York, U.S.A. (Agents, GEORGE WHIGHT & CO., 143 Holborn Bars, London, E.C.).—(1) Hand Celestinas. (2) Pedal Celestinas. (3) Orchestral Cabinets.

3543. BELL, W., & CO., Guelph, Ontario, Canada.—American Organs.

3544 & 3553. KELLY & CO., 14 & 16 Mortimer Street, London, W.—(1) American Organs: [a] Five octaves, one set vibrators. [b] Five octaves, five stops, vox humana. [c] Five octaves, nine stops, one and half sets vibrators, vox humana. [d] Five octaves, fifteen stops, two sets vibrators, vox humana, sub bass, sub and super couplers, full organ pedal, decorated pipe top. All the above have patent crescendo knee swells. (2) Harmoniums: [a] Five octaves, one set reeds. [b] Five octaves, eight stops, one and half sets of reeds, knee swells. [c] Five octaves, fifteen stops, four and half sets reeds, full organ knee pedal, voix céleste. Effective fortes.

3545. GAVIOLI, C., FILS, Rue des Charbonniers 15, Paris (Agent, S. LOMBARDI, 21 Noel Street, Soho Square, London, W.).—Harmonisateur.

3546. KASTNER, FRIEDRICH (per VEUVE DE G. KASTNER, Boursault, Baden-Baden).—A Pyrophone.

3547. HAMAND, ARTHUR S., Palace Chambers, Bridge Street, London, S.W.—Wind Valve or Pallet.

3548. BAUER, GILBERT L., & CO., 21 King's Road, St. Pancras, London, N.W.—Harmoniums and American Organs.

3550. BAYNTON & CO., 23 Bayford Street, Mare Street, Hackney, London, E.—Harmoniums, Harmonium and American Organ Cases, and Harmonium Pans or Sound Boards.

3551. LAUKHUFF, AUG., Weikertshausen, Württemberg (Agent, PHILIP BORN, 53 Queen's Road, Bayswater, London, W.).—Chamber Organ.

3552. BROWN, RICHARD, 324 Kennington Road, London, S.E.—Cabinet or Student's Organ with two manuals and pedals.

3554. PETILLO, GIOVANNI, Via Duomo, Palazzo Solombrino, Naples.—Glass Harmonicon.

3555. BLENNERHASSET, J. F., 1a Vernon Street, Pentonville, London, W.C.—Automatic Hydraulic Engine, suitable for supplying wind to harmoniums and American and church organs from the smallest size to the largest calibre.

3556. WALLIS, JOSEPH, & SON, 133 & 135 Euston Road, London, N.W.—Harmoniums.

3556. BESSON, F., & CO., 198 Euston Road, London, N.W.—(1) Reduced Compact and light musical Instruments. Special models for juvenile use, easy to blow and extra strong. (2) Ancient Chinese Instruments, Paper, Plaster of Paris, Gutta Percha Instruments, manufactured on the Besson Prototype system. (3) Regulation Bass, Side and Kettle Drums, Skeleton Drums, and the new Orchestra Drum, combining side and kettle drums, triangle, and castanets. For small orchestras, and equally suitable for band purposes on the march. The new Simplex Side Drum, for equally adjusting tension of head. (4) Clarionets, Flutes, Oboes, Bassoons, &c. With new improvements suitable for hot climates. (5) Glockenspiels and Military Chimes.

3557. BOOSEY & CO., 295 Regent Street, London, W.—(1) Brass Instruments, with the patent compensating pistons, and models illustrating the construction of the same. (2) Brass Instruments on the light valve system. (3) Brass Instruments on the slide system [trumpet and trombones]; models and specimens of work. (4) Flutes, on the systems of Pratten, Siccama and Boehm, and Reed Instruments of all kinds in ebonite and box wood. (5) Drums and other percussion instruments.

3558. ALBERT, JACQUES, Brussels Agent, S. A. CHAPPELL, 52 New Bond Street, London, W.—Combination of Metal Tube covered with Vulcanized Caoutchouc instead of wood in the manufacture of musical instruments.

3558. CHAPPELL, S. A., 52 New Bond Street, London, W.—Wood and Brass Musical Instruments.

3559. IHLEE & SANKEY, 31 Aldersbury, London, E.C.—Metal Flageolets stages of construction.

3560. MEZZOTTI, A. E., 16 Surrey Villas, Woodland Road, Upper Nor-

wood, London, S.E.—The Improved Ocarina with tuning slide.

3561. BIASOTTI, GIOVANNI.

3562. POTTER, HENRY, & CO., 30 Charing Cross, London, S.W.—(1) Cornets, Bass Wind Instruments, Flutes, various improved Clarionets, Bassoons, improved. (2) Orchestral Kettle Drums, with improved tuning apparatus; Quadrille Side Drum, new model. (3) Steel Heated Drum.

3563. ORSI, PROFESSOR ROMEO, 6 Via Monforte, Milano, Italy.—Clarinet.

3564. KEAT, HENRY, & SONS, 105 Matthias Road, London, N.—(1) Military Band Instruments and Fittings. (2) Bugles, Trumpets, &c. (3) Horns, for hunting and all other purposes. (4) New Model Telescope Coach and Post Horns. (5) The Buglet, a new instrument, invented for cycling, &c. (6) Band Flutes.

3565. MOLLENHAUER, J., & SOEHNE, Fulda, Germany (Agent, W. MACHON, 13 Savoy Buildings, Strand, London, W.C.).—(1) Flutes. (2) Clarionets. (3) Oboes, &c.

3566. BRIZZI E NICCOLAI, Via Certani 12, Florence, Italy.—(1) Flute. (2) Clarinet.

3567. LIGGINS, HENRY, 3 Ladbrooke Square, Notting Hill, London, W.—Flute with Low B Key, mounted in sterling silver.

3568. BEEBY, W. H., 14 Ridinghouse Street, London, W.—Cut Glass Concert Flute.

3569. WALLIS, JOSEPH, & SON, 133 & 135 Euston Road, London, N.W.—Flutes, Fifes, Flageolets, Clarionets, Oboes, Musettes, Castanets, Clappers, Conductors' Batons, Drum Sticks, and Wood Turning generally.

3570. WEBSTER'S PATENT ALUMINIUM CROWN METAL CO., Limited, 34 Leadenhall Street, London, E.C.—(1) Organ Reeds. (2) Piano Cases and Wire. (3) Flutes, Horns, Drums, &c.

3571. LAMY & CO., 10 Charterhouse Street, London, E.C.—Wind Instruments.

3572. RUDALL, CARTE, & CO., 23 Berners Street, London, W.—(1) Indestructible Ebonite Clarionets. (2) Flutes. (3) Piccolos. (4) Bassoons. (5) Brass Band Instruments. (6) Patent Double-Slide Trombones. (7) Drums. (8) Ravyn Model French Horns [Kneller Hall Pattern]. (9) New and Old System Oboes in ebonite and wood.

3573. MAHILLON, C., & CO., 42 Leicester Square, London, W.C.—Musical Instruments, brass, wood, and ebonite.

3574. HOPKINSON, J. & J., 95 New Bond Street, London, W.; and Fitzroy Road, N.W.—(1) Horizontal and Upright [overstrung and vertical] Iron Grand Pianofortes. (2) Pianofortes for extreme climates. (3) Pianofortes with patent organ-pedal attachment. (4) Patent Organ Pedal. (5) Models of Actions. (6) Designs for pianoforte cases.

3575. CHALLEN & SON, 49 Oxford Street, London, W.—Pianos: (1) Upright Grand in Chippendale case. (2) Iron Grand, Cross String Bass. (3) Colonial Model Solid Case. (4) Iron Bordoir for extreme climates. (5) Iron Cottage. (6) Pianette.

3576. KIRKMAN & SON, 3 Soho Square, London, W.—(1) Grand and Upright Pianofortes with steel and iron frames. (2) Harpsichords, &c.

3577. BROADWOOD, JOHN, & SONS, 33 Great Pulteney Street, London, W.—(1) Concert Iron Grand Pianoforte in Oak Case. (2) Concert Iron Grand Pianoforte in Ebonized Case. (3) Case, Soundboard, Iron framing, &c., of Concert Iron Grand Pianoforte. (4) Case, Soundboard, Iron Framing, &c., of Cottage Pianoforte, composite construction. (5) Original Iron Grand Pianoforte, A.D. 1847. (6) Grand Pianofortes, played upon by Frederic Chopin, A.D. 1848. (7) Transposing Cottage Pianoforte, A.D. 1845. (8) Transposing Square Pianoforte, A.D. 1808. (9) Original Cottage Pianoforte, invented by Hawkins, A.D. 1800. (10) Wülfel's Iron Back for a cottage piano. (11) Handel's Tuning Fork and an old Tenor Fork, both exhibited by the Rev. G. T. Driffild. (12) Tuning Machine, Authentic Tuning Forks, Models, &c.

3578. BING, FEDOR, Dresden.—Piano and Models.

3579. OUTRAM, E., Greetland, near Halifax.—Improvements in pianoforte stringing.

3580. COLLARD & COLLARD, 16 Grosvenor Street, Bond Street, W.; and 26 Cheapside, London, E.C.—Metal-frame Grand and Cottage Pianofortes, in walnut, satinwood, and ebonized cases.

3581. SNOW, MARY, 111 Chester Road, Kidderminster.—Patent Self-teaching Pianoforte.

3582. ALIBERT, J. P., 2 Rue Masseran, Paris.—Pianos, Violins, &c.

3583. POHLMANN & SON, 64 Berners Street, London, W.; and Princess Street, Halifax, Yorkshire.—(1) Horizontal new patent double frame Iron Grand, 7½ octaves, equal tension, bridge, &c. (2) Upright Overstrung Sovereign Grand Piano, with the patent iron double frame, 7½ octaves. (3) Patent Piano d'Artiste, upright. (4) New Model Pianoforte. (5) Models of improvements in pianofortes, iron double frames.

3584. RUDD, A., 74 Dean Street, Soho Square, London, W.—A Grand Piano, by Clementi, of peculiar construction, having an extra harmonic pedal and a double length of vibrating string to each note.

3585. BISHOP, E. & SONS, Belmont Works, Chalk Farm Road, London, N.W.—Pianos.

3586. BLÜTHNER, JULIUS, 7 Wigmore Street, London, W.—(1) Grand Pianofortes with Cupola Metal Frames, and the Blüthner Patent Aliquot Scaling, &c. (2) Upright Pianofortes, with metal frames, metal bridges, and agraffes, compressed soundboards in concave forms, overstrung scaling, &c. (3) Specimens of Metal Castings. (4) Sections of Upright and Grand Actions. (5) Hammer Felts. (6) Section of Aliquot Scaling. (7) Square and Round Music Stool. (8) Diagrams and Drawings, &c.

3588. SQUIRE, WILLIAM HENRY, 94 Camden Street, Camden Town, London, N.W.—Self-compensating Double-strung Portable Grand Pianoforte.

3589. BRINSMEAD, JOHN, & SONS, Wigmore Street, London, W.—(1) Concert Grand, with patent leverage, sounding board, &c. (2) Semi Grand, with patent screw tuning pins and continuous iron frame. (3) Drawing room Grand, with patent mechanism and tone sustaining pedal. (4) Skeleton Piano, with patent screw tuning apparatus and metal action, &c. (5) Upright Piano, with patent leverage sounding board, &c. (6) Models; patent iron frame, patent screw tuning apparatus, patent check action, patent simplex action, patent grand check action, patent leverage sounding board, &c.

3590. HÜNI & HÜBERT, Zurich, Switzerland.—Pianos.

3591. HUNDT & SOHN, Stuttgart, and 61 Baker Street, London, W.—Vertical and Overstrung Pianos.

3592. STEINWAY & SONS, Steinway Hall, New York, U.S.A.; and Steinway Hall, Lower Seymour Street, London, W.—(1) Pianos. (2) Models to illustrate process of manufacture.

3593. MANSFELDT & NOTEL, Dresden (Agent, E. PARR, 16 Long Lane, London, E.C.).—Iron Frame Piano.

3594. ZEITZER & WINKELMANN, Braunschweig (Agents, SCHMIDT, ESBSLOH, & CO., 86 & 87 Monkwell Street, London, E.C.).—Pianos.

3595. BURLING & BURLING, 64 Hampstead Road, London, N.W.—Upright Pianos and models of work.

3596. NOSWORTHY, WILLIAM SAMUEL, 71 Coldharbour Lane, Camberwell, London, S.E.—(1) Dissecting Model of patent upright over-strung iron grand pianoforte, with two sounding-boards. (2) Dissecting Model of patent pianoforte.

3597. BORD, A., Paris (Agent, STILLES, CHARLES, & CO., 42 Southampton Row, Holborn, London, W.C.)—Horizontal Grand and Upright Pianos.

3598. LONDON MUSIC PUBLISHING AND GENERAL AGENCY CO., Limited, 54 Great Marlborough Street, London, W.—Pianoforte.

3599. HOFMANN, CARL, Frankensgasse 28, Wien (Agents, SCHMEIDES, ESBSLOH, & CO., 36 & 37 Monkwell Street, London, E.C.)—Pianofortes.

3600. HAAKE, Hagen Strasse, Hannover (Agent, E. PARR, 16 Long Lane, London, E.C.)—Upright and Horizontal Iron Framed Grand Pianofortes, harmonic.

3601. FLEYEL, WOLFF, & CO., 22 Rue Rochechouart, Paris.—Pianos.

3602. RUSSELL, G., & CO., 2 Stanhope Street, Euston Road, London, N.W.—Pianos in Marquellerie cases.

3603. ROGERS, GEORGE, & SONS, 2 High Street, Camden Town, London, N.W.; and 72 Colmore Road, Birmingham.—Pianos.

3604. SCHIEDMAYER & SOEHNE, Necker Strasse, Stuttgart.—Upright Iron Frame Piano, Patent Check Repetition.

3604. WARD, R. J., & SONS, St. Anne Street, Liverpool (Agent, E. PARR, 16 Long Lane, London, E.C.)—A Specimen Banjo and Small Musical Instruments.

3605. MUIR, SMITH, & CO., 116 & 118 Bayham Street, Camden Town, London, N.W.—(1) Vertical Iron Grand Sosteruto Pianofortes. Drawing-room model. (2) Model of Sosteruto Sound Board for increasing, preserving, and sustaining the tone of pianofortes.

3606. MOORE & MOORE, 104 & 105 Bishopsgate Street Within, London, E.C.—(1) Vertical Iron Frame, for pianofortes, without breaks. (2) Part of an Iron Frame [wrest plank] for pianofortes for extreme climates. (3) Guildhall Model [iron frame]. (4) Iron Cottage and Overstrung Upright Grand Pianofortes. (5) Harmonium [harmonic tuning to design of A. T. Ellis, F.R.S.].

3607. MONINGTON & WESTON, 8 Holborn Viaduct, London, E.C.—Pianos.

3608. RÜDOLF, IBACH SOHN, Harmer, Germany; and 18 Hamsell Street, London, E.C.—Horizontal and Upright Grand and Cottage Pianofortes.

3609. WARD, HENRY, 100 Great Russell Street, Bloomsbury, London, W.C.—Pianofortes of improved construction, iron framed, vertical and overstrung, grand cottages and pianettes.

3610. TOLKIEN, HENRY, 51 King William Street, London, E.C.—Pianos.

3611. HAYESTAFF, WILLIAM GLEN, 14 Berners Street, Oxford Street, London, W.—Upright, and Oblique Pianofortes, in metal frames, with varied check actions.

3612. TOOMBS, F., Lowther Penrith.—Patent Pianoforte and Model of Chromatic Keys.

3613. RAYM & SOHN, KIRCHHEIM & TECK, Stuttgart (Agents, STANLEY LUCAS, WEBBER, & CO., 84 New Bond Street, London, W.)—Pianofortes.

3614. ROSS, WILLIAM HENRY, 29 Norfolk Terrace, Hayswater, London, W.—Pianoforte.

3615. METZLER & CO., 42 Great Marlborough Street, London, W.—(1) Patent Upright and Grand Organo-Pianos. The solution of the problem how to produce continuous vibration of the strings of a pianoforte. (2) Victor Mustel's Harmoniums, sometimes called Mustel Organs.

3616. STROHMENGER, J., & SONS, 169, 177, & 206 Goswell Road, London.—(1) Walnut Cottage Piano, of new design, iron frame, vertical, with improved under damper action. (2) Black and Gold Model, iron frame piano, full trichord, with patent check action.

3617. ALLISON, RALPH, & SONS, Limited, 167 & 169 Wardour Street, London, W.—Pianofortes—(1) A Burr Walnut, vertical iron frame, full trichord, check action, ivory keys and fronts, &c. (2) A Black and Gold, trichord treble, check action, medalion panel, trusses on a plinth, ivory keys and fronts, &c. (3) A Rosewood, trichord treble, metal mounted panel, brackets on a plinth, ivory keys and fronts, &c.

3618. WARNER, MRS. CLARA B., 7 Palham Place, South Kensington, London, S.W.—Keys for Pianos, Organs, &c.

3619. WEBSTER, HORSFALL, & LEAN, 15 Bromsgrove Street, Birmingham.—Music Wire.

3620. BONY, C., Rue Titon 15, Paris.—Models of different parts of Piano.

3621. FELTEN & GUILLAUME (Agents, W. F. DENNIS & CO., 101 Leadenhall Street, London, E.C.)—Patent Steel Music Wire.

3622. DE ROHDEN, C. E., Rue St. Maur 185, 187, 189, Paris.—Improvements in Pianos, &c.

3623. QUITMANN & CO., 182 Queen Victoria Street, London, E.C.—Machine Covered Pianoforte Felt Hammers.

3624. MALLINSON, J., 32 High Street, North Finchley, London, N.—Patent Pianoforte Action.

3625. SCHUCHT & SCHÖNEWALD, 14 Store Street, Bedford Square, London, W.C.—(1) Pianoforte Tuning Machine. (2) Pianoforte Hammer Covering Machine.

3626. VIVIER ET OOR, Rue du Parchemin 18, Brussels (Agents, GARNER & CO., 18 Queen Victoria Street, London, E.C.).—(1) Piano. (2) Apparatus to take the place of pegs used for stretching piano strings.

3627. POCOCK & SON, 103 Westbourne Grove, Bayswater, London, W.—Pianos with New Patent Durable Actions.

3628. DORNER, G., & SOHN, Stuttgart, Germany.—Pianos, &c.

3629. BOYLE, RICHARD B., JUNIOR, 73 Blessington Street, Dublin.—(1) Musical Trophys, carved in satin wood. (2) Carved Frontispiece. (3) Original Designs, &c.

3630. CHAPPELL & CO., 50 New Bond Street, London, W.—Pianofortes. Specialities for schools, yachts, ocean steamers, and extreme climates.

3631. MONTI, CH., 127 Rue Oberkampf, Paris (Agents, C. ERHARDT & CO., 38 & 39 Brooke Street, Holborn, London, E.C.).—Pianoforte and Organ Keys.

3631. KNEIP, A., 182 Avenue Parmentier, Paris (Agents, C. ERHARDT & CO., 38 & 39 Brooke Street, Holborn, London, E.C.).—Pianoforte Hammers.

3631. GEHRLING, CH. FILS, 59 Rue de l'Oureq, Grande Vilette, Paris (Agents, C. ERHARDT & CO., 38 & 39 Brooke Street, Holborn, London, E.C.).—Pianoforte Actions.

3632. HERRBURGER & SCHWANDER, Rue de l'Évangile 16, Paris.—Pianoforte Actions.

3633. RUSHTON, JAMES, 1 Prospect Villas, Prospect Road, Finchley Road, Child's Hill, London, N.W.—Section of Cottage Pianoforte, with one set of patent organ pedals showing patent simplex and independent attachments, applicable to a piano with under or over dampers.

3634. WÖRNER, G., Stuttgart (Agent, R. HUNDT, 61 Baker Street, London, W.).—Machine Covered Hammer Heads for Pianos.

3635. RENNER, LOUIS, Stuttgart (Agent, R. HUNDT, 61 Baker Street, London, W.).—Patent Check Actions for Grand and Upright Pianos.

3636. WEBB, G. & A., 9 North End; and 77 George Street, Croydon.—Model of portion of Pianoforte Action, showing metallic damp proof escapement and regulating hopper for sticker actions.

3636. CRIPPS, THOMAS HENRY, 3 Park Terrace, Oval Road, Croydon.—Model of a perfectly new system of under damping for pianofortes fitted with plain hopper action.

3637. FÖRSTER, AUG., Loeban, Saxony (Agents, SCHMEDES, ESBSLOH & CO., 36 & 37 Monkwell Street, London, E.C.).—Pianofortes.

3638. SCIEPO & SCIEPO, 595, 597 Old Kent Road, London, S.E.—Pianofortes.

3639. RITMÜLLER, W., & SOHN, Goettingen, Hanover (Agents, SCHMEDES, ESBSLOH & CO., 36 & 37 Monkwell Street, E.C.).—Pianos.

3640. KILVERT, J. SMITH, 73 Queen's Road, Bayswater, London, W.—(1) Improved Piano Felt for hammers. (2) New Machine Covered Hammers. (3) New Design in Cottage Piano with machine covered hammers.

3641. OETZMANN, THOMAS, & CO., 27 Baker Street, London, W.—Pianofortes.

3642. POHLMANN & SOHN, Pferde Markt 21, Hamburg.—Hamburg Model Upright Grand Pianofortes.

3643. KLITZ, CHARLES J., 26 Hanway Street, Oxford Street, London, W.—(1) Upright Grand Pianoforte, vertical iron frame. In rosewood and marqueterie, inlaid case, Ormolu sconces, &c. (2) Cottage Pianoforte, vertical iron frame, Chippendale case. (3) Weighing Machine to ascertain the tension of any separate wire with a diagram, showing the strain upon an ordinary pianoforte.

3644. HAMPTON, CHARLES, & CO., 74 Charlotte Street, Fitzroy Square, London, W.—(1) The Royal College of Music Piano. (2) Upright Pianos of new construction. (3) Model showing construction with model of action.

3645. DUNKLEY, WILLIAM, 101 High Street, Clapham, London, S.W.—Vertical Strung and Overstrung Steel Frame Pianofortes.

3646. REICK, J.,

3647. BROOKS, H., & CO., 31 Lyme Street, Camden Road, London, N.W.—(1) Pianoforte Actions and Keys. (2) Music Stools and Furniture.

3648. BROWNE, JUSTIN, 237-243 Euston Road, London, N.W.—(1) Vertical and Overstrung Upright Iron Grand Pianofortes. (2) Improved Iron Castings, specially prepared with a coating for condensing and neutralizing the metallic sympathetic tone produced by iron string frames.

3649. HEMINGWAY & THOMAS, Victoria Road, Kentish Town, London, N.W.—Ordinary Upright Grand Pianofortes.

- 3650. McVAY, CHARLES, 197** Kentish Town Road, London, N.W.—(1) Black and Gold Upright Iron Grand Piano. Constructed with sustaining sounding board; fitted with imperial check repeating action. (2) Persian Walnut Composite Iron Grand Piano, with Sostenuto sounding board. Fitted with new patent acme check-repeating action, and sustaining pedal producing orchestral effects.
- 3651. SQUIRE & LONGSON, Royal** Park Buildings, Arlington Road, London, N.W.—(1) Vertical Iron-frame Piano, renaissance style, mahogany and rosewood, new patent check action, tone sustaining and staccato pedal, new induction, damp-proof sounding board. (2) Walnut Piano, Iron Frame, Acme check action and induction sounding board.
- 3652. WHITFIELD, EDWIN, & CO.,** Small Heath, Birmingham.—Cast-Iron Piano Frames, &c. Also fittings in brass, gun-metal, and nickel-plated.
- 3653. AJELLO, GIULIANO, 104** Park Street, Camden Town, London, N.W.—(1) Three Pianofortes, viz.: Iron Upright Grand, Double Overstrung, Single Overstrung, and Vertical. (2) The Gem Patent Self-acting Music Leaf Turnover.
- 3654. PARFITT, WILLIAM J., Piano** Works, Caledonian Road, Holloway, London, N.—(1) Steel-Framed, Full Trichord Cottage. (2) Upright Grand and Special Pianette Pianofortes.
- 3655. THIBOUVILLE-LAMY, J., & CO., 10** Charterhouse Street, London, E.C.—(1) Pianos. (2) Pianistas. (3) Harmoniums. (4) Brass and Wood Wind Instruments. (5) Violins. (6) Fittings, &c.
- 3656. BOHMER, H. B., 153 Balls Pond** Road, London, N.—Thürmer Pianos.
- 3657. STEPHEN, JAMES, 54 Queen** Street, Camden Town, London, N.W.—Pianos, strung back, trussed sounding board and iron frame.
- 3658. VENABLES, C., & CO., 187-189** Essex Road, Islington, London, N.—(1) Two Folding or Cabin Pianos, specially prepared to resist the injurious effects of damp atmosphere. Hammers waterproofed and fitted with patent automatic rail for protection when not in use. (2) An Early English Piano, with bass sustaining pedal.
- 3659. OETZMANN, FREDERICK, & SONS, 38** Conduit Street, Regent Street, London, W.—Art Pianos; also Art Pianos, fitted with their patent Nouveauté music repository.
- 3660. HÖLLING & SPANGEN-**BERG, Zeitz (Agents, BARNETT & SONS, 32 Worship Street, London, E.C.)—Grand and Cottage Pianofortes.
- 3661. BARRATT & ROBINSON,** 810a York Road, Camden Road, London, N.—Upright Pianos and their Patent Lever Butt Repetition Check Actions.
- 3662. DREAPER, W. H. & G. H., 96** Bold Street; and 103 Wood Street, Liverpool.—Oblique Iron Grand Pianofortes with patent sounding boards.
- 3663. BREWER, SAMUEL, 28 & 30** Great Eastern Street, Shoreditch, London, E.C.—Pianofortes, Models of construction and adjustable vocal desk.
- 3664. DOWNING, D. F.,**
- 3665. HOWSON, RICHARD, 2 Ex-**change Place, Middlesbrough-on-Tees.—Patent Piano, crescendo or piano-forte, with expression pedal.
- 3666. ELIAS, G., Stuttgart, Germany.**—Patent Harp Piano.
- 3667. RUMMENS, H. J., 47 Church** Road, Brixton, London, S.W.—Improved means of applying Organ Pedals to Pianofortes, for the practice of organ music with the same facility as at the organ.
- 3668. EASON, A., 217 & 219** Kentish Town Road, London, N.W.—Vertical Full Trichord Iron-framed Pianofortes, with brass pin plates and four pedals.
- 3669. SCHUCHT & SCHÖNEWALD,** 14 Store Street, Bedford Square, London, W.C.—Cottage Pianoforte, overstrung, and without brake in the action and keys.
- 3671. WRIGHT, G., & CO., 143** Holborn Bars, London, E.C.—(1) Automatic Pianoforte, Cabinet Organ, Mantel Orchestrone. (2) Musical Cabinets, Tournaphone, Aurephone, Celestina, Clariona.
- 3672. AUTOMATIC MUSICAL IN-**STRUMENT CO., Limited, 3 Oophall Buildings, London, E.C.—(1) Pianos. (2) Miranda Pianistas.
- 3673. ALLISON, A., & CO., Apollo** Works, Leighton Road, Kentish Town, London, N.W.—Pianofortes.
- 3674. SQUIRE, A., 6 Wrotham Road,** Camden Road, London, N.W.—(1) Pianos. (2) Models of Pianoforte Action. (3) Magnet Setel Wires.
- 3675. BAMBERGER, LOUIS, 3** Broad Street Buildings, Liverpool Street, London, E.C.—Sounding Boards and other wood used in the manufacture of pianofortes.

3676. CALDERA, LUIGI, Via Po, No. 39 Turin, Italy.—Harp.

3677. ABBOTT, J. H., 2 & 4 Brill Street, St. Pancras, London, N.—(1) Practical Model of a $5\frac{1}{2}$ octave Piano for practice, with small resonant sounding board. (2) Shifting and Sliding Desk for upright pianos.

3678. STUTTFORD, JOHN, Somerset Road, New Barnet, Herts.—(1) Pédalier d'Etude, or a Set of Organ Pedals for student's home use attached to piano.

3679. BEARE & SON, 84 Rathbone Place, London, W.—The Voixophone. A musical instrument of novel construction, the tone of which is produced by simply breathing gently through a tube acting upon reeds.

3680. CHEVREL, G., Paris (Agent, M. LOUIS, 72 Huddleston Road, Tufnell Park, London, N.).—Inlaid names, marqueterie, and artistical network for pianos.

3681. BOURRY-AMANS, JEAN, HUNI & HUBERT, Fabric de Pianos, Zurich, Switzerland.—Improved Grand Pianos.

3684. CRAMER, J. B., & CO., 189, 201, 207, & 209 Regent Street, London, W.; also Brighton and Liverpool.—Pianos and Pianettes.

3686. RAMSDEN, A., 12 Park Row, Leeds.—(1) Pianos. (2) Vocalions. (3) Melody and Pedal Substitute Organs.

3691. TAYLOR, J. & J. A., Lower Edmonton, Middlesex.—(1) Patent Double-strung Violins. (2) Specimens of Violin Music-holder. (3) Improved Violin Cases. (4) New designed Violin Bridges.

3692. CHANOT, GEORGE, 157 War-dour Street, London, W.—(1) Double Bass 4-String Instrument. (2) Violoncellos. (3) Violas. (4) Violins, &c.

3693. DUNCAN, GEORGE, 16 Queen Street, Glasgow.—Violins.

3694. PEARCE, WILLIAM ROBERT, 16 Huntingdon Street, Barnsbury, London, N.—(1) Violins. (2) Viola, varnished with amber oil varnish.

3695. LOWENTHAL, L., 1b Wieland Strasse, Dresden, Saxony.—(1) Violins. (2) Violoncello. (3) Tenor Viola. (4) Double Bass. (5) Bows. (6) Chin-holders, &c.

3696. SPRINGER, LA., Stuttgart, Germany.—(1) Two Violins, fitted with a patent tone screw. (2) An improved form of Rosin

Box. (3) Strings for Violin and Violoncello. (4) The Violinist's Companion in the form of a pocket knife. (5) An Improved Chin-rest.

3697. JÜHLING, F., Dresden.—(1) Violins. (2) Viola.

3698. WILLIAMS, S., 12 Lansdown Parade, Cheltenham.—Bow Guides for violin, viola, &c.; a small appliance easily fixed to any size violin, &c., to ensure correct bowing.

3699. JENOUR BROTHERS, 49 Theobald's Road, London, W.C.—Adjustable Chin-holder for the violin or viola [Upton's Patent]. This holder can be fixed immediately over the tail-piece of the instrument, and adjusted to any height or set to any angle to suit each individual performer.

3700. LANE, J. Q., 82 Alfred Terrace, Mount Pottinger, Belfast.—Improved Violin Bridge, by which a fuller, richer, and more uniform quality of tone is obtained in all strings.

3701. GARRETT, G. F. H., 19 Der-mant Street, Derby.—Violin Head, fitted with an improved appliance to facilitate tuning.

3702. McKINNON, WILLIAM, 47 Water Street, Leith.—Barral or Caak Violin.

3703. HASSAM, CHARLES, 65 Frith Street, London, W.—Violin and Bow.

3704. WALLIS, JOSEPH, & SON, 138 & 135 Huston Road, London, N.W.—Violins, Violas, Violoncellos, Guitars, Mandolines, Banjos, &c., fitted with Wallis' Patent Holdfast Pegs.

3705. TWINING, T., Ferryng House, Twickenham.—Cellino or Ladies' Violoncello with bow and case. Also metrical String Gauge.

3706. LORNE, V. A., 35 Richard Street, Liverpool Road, London, W.—Patent Violin Cases.

3707. WOOD, THOMAS, Blindley Heath, Godstone.—(1) Specimens of Transparent Amber Varnish in Oil. (2) Instrument for registering the harmonics of single musical sounds.

3708. LAMY, T., & CO., 10 Charter-house Street, London, E.C.—Violins, &c.

3709. DEAN, JOSEPH, 77 City Road, London, E.C.—Patent Machine Pegs for violins, viola, and violoncello, by which the tone may be regulated to the finest degree, with the greatest ease, and in the shortest space of time, also they cannot slip.

3710. MEESON, RICHARD, 14 Colebrook Row, Islington, London, N.—(1) New and Patented adaptation of Double Curved Bass Bar to Violins, Violoncellos, and Double Basses. (2) Screw Violoncello Pegs. (3) Steel Violoncello Pegs. (4) New Music Stand, shuts up into 1 in. space. (5) New Double Bass Stool. (6) Double Bass. (7) Machines. (8) Double Bass, engraved and gilt.

3711. BISHOPP, GEORGE D., Endlands, Willesden Green, London, N.W.—Violins.

3712. CHANOT, G. A. & CO., 48 Great Ducie Street, Manchester; and 8 Deane Street, Liverpool.—(1) Violins, finished, and in the white. (2) Viola, in the white. (3) Violoncello [model of a fine Stradivarius] partly varnished. (4) Bows. (5) Materials, Tools, and Appliances used in violin making. (6) New Patent Bag Case.

3713. METZLER & CO., 42 Great Marlborough Street, London, W.—(1) Violins and Stringed Instruments, Fittings, &c. (2) Improved Brass and Reed Instruments, Fittings, &c.

3714. DOSI, PIETRO, S. Vitale 86, Bologna, Italy.—(1) Viola. (2) Violins and Violin-holders.

3715. FIORINI, GIUSEPPE, Via Castiglione 8, Bologna, Italy.—Violins.

3716. DE BORZI, VALENTINE, Pistoga, Italy.—(1) Violins. (2) Violoncellos, &c.

3717. BOARDER, JAMES, 332 Uxbridge Road, Shepherd's Bush, London, W.—The Combination Violin Case and Music Support.

3718. LINDSAY, M. H., 7 Starkey Street, Stockton-on-Tees.—Violas and Violins.

3719. ASKEW, JOHN, Stanhope, Darlington.—Violins.

3720. HILL, WILLIAM E. & SONS, 72 Wardour Street, London, W.—(1) Violins and a Violoncello. (2) Bows. (3) Cases of a New and Improved Construction. (4) A new Patent Chin-rest and Shoulder-pad combined. (5) A new String Gauge. (6) A mixture for making pegs work well, and a lubricator for easing the working of the strings over nut and bridge. (7) Parts of Violins, showing process of manufacture.

3721. GILBERT, JEFFERY J., New Romney, Kent.—(1) Violins in various sizes, models, and colours, and violas in two sizes. (2) Patent Folding and Telescopic Music and Reading Stands.

3722. BOULLANGIER, CHARLES, 16 Frith Street, Soho, London, W.—Violins, Violoncellos, and Tenors.

3723. PACKHAM, JAMES, 16 Katharine Street, Croydon.—(1) English hand-made Violins. (2) Specimens of Amber Oil Varnish, and transparent colours on Wood. (3) Various specimens of amber gum, &c.

3724. WHITMARSH, EMANUEL, 4 Holmes Street, Great Cambridge Street, Hackney Road, London, E.—Violoncellos, Tenors, and Violins.

3725. GEMÜNDER, GEORGE, Astoria, Queen's Co., New York, U.S.A.—Imitations of Antonius Stradivarius, Joseph Guarnerius, and Maggine Stringed Instruments.

3726. STUTTAFFORD, JOHN, Somerset Road, New Barnet, Herts.—(1) Tuning Pegs for bow instruments. (2) Tail Pieces for ditto, to facilitate stringing. (3) Bow Resin, spherically shaped. (4) Spring Leaf or Bookholders. (5) Improved String Boxes.

3727. MAYSON, WALTER H., Croft House, Newby Bridge, Windermere.—Violins, Viola, and Violoncello.

3728. HAMMIG, W. H., Munzgasse 221, Leipzig, Germany.—(1) Violins. (2) Viola. (3) Violoncellos.

3729. SZEPESSY, RÉLA, 10 Gerrard Street, Soho, London, W.—Violins.

3732. INGRAM, E., Burnard Place, Eden Grove, Holloway, London, N.—Specimens of old Organ Pipes and Mounted Cornets.

3733. IMHOF & MUKLE, 110 New Oxford Street, London, W.C.—(1) Self-acting Orchestration. (2) Barrel Organ.

3734. HODGSON, A. P., 4 Moreton Place, London, S.W.—(1) Pianograph Metronome. Instrument for effecting the accurate transcription of all musical compositions. It can be adapted to any pianoforte, and prints the music whilst it is being played. (2) Melodia. A small apparatus for the mechanical playing of pianofortes and other keyboard instruments.

3735. CHIAPPA, G. & SON, 6 Little Bath Street, Clerkenwell, London, E.C.—Mechanical Barrel Organs and Pianos.

3737. DE NYDPRUCH, COMTE, 5 Rue van Orley, Brussels (Agents, GARNER & CO., 18 Queen Victoria Street, London, E.C.).—Patent Metal Piano.

3738. HUNTER-SLOCOMBE, R., 23 Colebrook Road, Walthamstow, Essex.—Musical Boxes in Swiss carved cases.

3739. NICOLE FRÈRES, 21 Ely Place, London, E.C.—Musical Boxes, including those which play for three hours with once winding, and musical boxes on a new principle for interchangeable cylinder.

3740. GILLETT & CO., Clock Fac- tory, Croydon.—Musical Clocks.

3741. WEIR, M. A., 3 Palace Grove, Upper Norwood, Surrey.—Automatic Musical Instruments and Music Writer.

3742. BEUTNER, KÜHN, & CO., 174 Addle Street, Aldermanbury, London, E.C.—Mechanical Musical Instruments, Ariston.

3743. TOURNAPHONE MUSIC CO. (THE), 9 May Street, Worcester, Mass., U.S.A. (Agents, G. WRIGHT & CO., 143 Holborn Bars, London, E.C.).—Aureophones, Tournaphone, Cecilia Organ, Automatic American Organs.

3744. KARRER & WOHNLICH, Teufenthal, near Aarau, Switzerland (Agent, P. BORN, 53 Queen's Road, Bayswater, London, W.).—Musical Boxes.

3745. REBIECK, G., Prag, Germany.—Musical Boxes.

3746. PERRELET, A., & CO., 18 Rue de Alpes, Geneva, Switzerland.—Improved Musical Boxes.

3747. LANGDORFF & FILS, Geneva, Switzerland.—Musical Boxes and Furniture.

3748. MANGER, JOHN, & CO., 26 & 27 Bartlett's Buildings, Holborn Circus, London, E.C.—(1) Musical Boxes. (2) Musical and Mechanical Novelties. (3) Mechanical Harmoniums.

3749. PAILLARD & CO., 62 Holborn Viaduct, London, E.C.; Manufactory, St. Croix, Switzerland.—Specialities—The Plerodiennique Musical Box, The Interchangeable Barrel Musical Box.

3750. CHAINE, VICTOR ADOLPHE, 39 Robert Street, Hampstead Road, London, N.W.—(1) Orchestral Kettle Drums. (2) Improved Model New Shape Shells. (3) Newly Invented Sliding Feet. (4) New Reserve Cover, made to contain extra heads. (5) Own Model Side Drum.

3751. GARRETT & CO., 5 Great Smith Street, Westminster, London, S.W.—(1) Military Regulation Side Drums, with improved arrangement of screws and fittings for equalisation of tension. (2) Drum

Belts and Sticks, various patterns. (3) Flutes, Piccolos, and Cases in different styles.

3753. POTTER, GEORGE, & CO., Bank Corner, Aldershot.—Working Models of Army-Regulation Drums. Army-regulation bass, side, and kettle drums reduced to one-third scale for convenience of inspection.

3754. TIPPER, HARRY, 118 The Grove, Hammersmith, London, W.—(1) 2 Octaves (Chromatic) Hand Bells. (2) One Set of Gongs and Model of Great Tom of Lincoln.

3755. OLIVER, GEORGE, 127 Orm- side Street, Old Kent Road, London, S.E.—(1) Campanaphone Bell Instrument attached to a piano. (2) Chiming Actions on Small Bells, invented for church turret and handbells. (3) Bells, Tuning Forks, &c.

3756. HALL, JOHN JAMES, Upton, Slough, Bucks.—(1) Automatic Interlocking Gear for the prevention of injury to church bells and Chiming Hammers. (2) Template Model of Bell, with gear and chiming hammer. (3) Part Models of Gear, and Improved Chiming Manual.

3757. WARNER, JOHN, & SONS, Jewin Crescent, Cripplegate, London, E.C.—(1) Goslin's Patent System of Mounting Church Bells. (2) Warner's Carillons. (3) Warner's Musical Handbells.

3758. GLIER, GEBRÜDER, Mark- neukiothen.—(1) Violins. (2) Zithers.

3759. BROMLEY, C., 6 Eversholt Street, Camden Town, London, N.W.—Banjos, Tambourines, Fairy Bells, and Japanese Violins.

3761. TIEFENBRUNNER, G. Mu- nich (Agents, M. A. TURNER & CO., 14 Gledhow Terrace, South Kensington, London, S.W.).—Various kinds of Zithers and Melodions.

3762. FIEHN, H. V., Bez Spenger- gasse 23, Vienna.—Ocarina.

3763. TALLACK, H. T., Templeton, Selhurst Road, South Norwood.—Amateur made Banjos.

3764. WINDER, J. G., 12 Jeffreys Street, Camden Town, London, N.W.—Banjos.

3765. KEMP, S. W., 37 Kingsland Road, London, E.—Patent Trumpet Grog Metal Banjos.

3766. TILLEY, ARTHUR, 29 & 30 Westfield Road, Surbiton, Surrey.—Patent Banjos, finished and in the rough.

3767. **IHLEE & SANKEY**, 81 Aldermanbury, London, E.C.—Banjos of American Construction and Design, and parts of same in different stages of manufacture.

3771. **RICHARDSON, J. J.**, Gordon House, Belvedere, Kent.—Improved Set of Pianoforte Tuner's Instruments.

3772. **REYNOLDS, R.**, 4 Upper Rathbone Place, London, W.—Tuning Hammers and Tuner's Kit for tuning and repairing.

3773. **SCHMIDT, HEINRICH**, Garbergasse Nro. 195 im 2 Stock, Prag, Germany.—Tuning Lyra.

3774. **CAROZZI, G. NAPOLEONE**, 38 Thurlow Place, South Kensington, London, S.W.—(1) Pneumo-Diaphonic-Diaphragmometer. (2) Ortophone. (3) Teinometer. (4) Isochrone. (5) Kincurostophone. (6) Hygienic Music Rest. (7) Folding Stool. (8) A Large Plan, showing the history and progress of the art of music from the earliest to the present times. (9) Practical Suggestions on vocal culture, including the formation and preservation of the voice, and a new system of obtaining proficiency on solmisation and tablature.

3775. **PADBURY, R. H.**, Mildmay Park Works, Balls Pond, London, N.—(1) Patent Leaf Turner, the Indispensable. (2) Music Stands, with instantaneous grip, for open air and orchestral bands. (3) Improved Music Satchel.

3776. **GARLAND, MISS MARIA**, 10 Powis Square, Brighton.—Three Musical Games.—(1) Musical Dominoes. (2) Presto. (3) Who knows the notes best?

3777. **HORN & SON**, 151 Strand, London, W.C.—Patent Improved Regulating Digitum for finger exercise.

3779. **HINDLEY, C., & SONS**, 290-294 Oxford Street, London, W.—Improved Music Cabinets and Music Stools, Duet Seats, &c.

3780. **DICKINSON, HERBERT YOUNG**, Newbury.—Patent Apparatus for printing music when attached to a pianoforte or other key-board instruments, prints the music as it is played.

3781. **ZIMMERMANN & CO.**, 57 Farringdon Street, London, E.C.—Lamps for Musical Instruments.

3782. **CARY, ALPHONSE**, 47 & 48 Northbrook Street, Newbury.—(1) Bennett & Cary's Patent Folding Music Stands in iron and brass. (2) Music Stands nickel-plated. (3) Music Stands folded and fitted into violin case. (4) Adjustable Clips for music

stands, (5) Two Violins. (6) Violin Chin-pads and Chin-rests in ebonite, ebony, maple, and velvet covered.

3783. **AGAR, W. T.**, Milford House, Milford, Lymington.—Music Desk.

3784. **NORTH OF ENGLAND SCHOOL FURNISHING CO., Limited (THE)**, 121 Newgate Street, London, E.C.; and Darlington and Newcastle-on-Tyne.—(1) Patent Hygienic Music Chairs, Stools, and Desks. (2) Darlington Slateboards and Darlington Slates, fitted with adjustments for drawing to scale.

3785. **ABRAHAM, F. A.**, 6 Jeffrey's Square, St. Mary Axe, London, E.C.—Patent Folding Music Cabinets for classifying and storing sheet music.

3787. **WALTERS, J. F.**, 47 Queen's Road, Bayswater, London, W.—Improved American Portable Music Stand.

3788. **PEDDLE, JAMES**, Alpha Place, King's Cross, London, W.C.—Pedal Non-revolving Piano Seat.

3789. **SPRATT & CHURCHMAN**, 9 Erlanger Road, New Cross, London, S.E.—New Patent Portable Music Stand, when not in use has the appearance of an ordinary ebony walking stick.

3790. **SAMSON, E. (Deceased)**; represented by **J. STEVENSON**, 26 Paternoster Square, London, E.C.—Patent Music Stools.

3791. **GILBERT, J. J.**, New Romney, Kent.—Patent Folding and Telescopic Music and Reading Stands.

3792. **FORSYTH, JAMES**, Finchley New Road, Hampstead, London, N.W.—The Mozart Drawing Room Music Stand.

3793. **SAHL & CO.**, 36 Basinghall Street, London, E.C.—Patent Adjustable Pianoforte chairs and Stools.

3794. **MORRIS, CHARLES A.**, 21 Chaucer Road, Herne Hill, London, S.E.—Royal Music Satchel [patent], constructed for carrying music, &c., in a compact form, but without creasing or disfiguring same.

3795. **GURR, JOHN**, 32 Portland Street, Brighton.—An Improved Book Holder for music stands or desks.

3796. **SCHWENCKE, C.**, Kissingen Villa, Lower Merton, Surrey.—Patent Apparatus for giving strength and flexibility to the fingers.

3797. **MICHELL & THYNNE**, 26a Great Titchfield Street, Oxford Street, London, W.—Model Church Organ.

3798. **CASSON, THOMAS**, North and South Wales Bank, Denbigh.—(A) Casson's Patent Organ. Lower Clavier [West Organ] Great, Choir, Solo. Upper [East] Swell, Echo. The 5 divisions each have a pedal organ and separate allotment of manual and pedal couplers. (B) Roosevelt's tubular action. (C) Without adjustable combinations. (D) Pneumatic ventii-chests. (E) Pedals wind-coupled. (F) 27 Stops, 12 Couplers, 1146 Pipes.

3799. **HUBAR, JULIEN AUGUSTE**, Quais des Pêcheurs 41, Liège, France. —Violins and Alto with metallic strings.

3800. **MEYER, C. & SONS**, 1717 Chestnut Street, Philadelphia, U.S.A.—(1) Patent Iron Frame for piano. (2) Pianoforte.

3801. **NOTT, WILLIAM**, Cranleigh, Guildford. —Black Board with moveable diagrams, showing transition, chords, and intervals, in major and minor keys, based on the keyboard principle.

3802. **GREGORY, ELIJAH T.**, 49 Hanover Gardens, Kennington Park, London, S.E.—Large model of, and Charts and Diagrams for showing musical scales, signatures, &c.

3804. **ALLEN, C. Bruce**, 111 Cheyne Walk, Chelsea, London, S.W.—Section, with Plan of a Music Room or Hall.

3805. **MICHEL, JOSEPH**, Ostend, Belgium. —New Method for transposing music.

3806. **MOORE, EDWIN P.**, 58 Fenchurch Street, London, E.C.—(1) Musical Sliding Scale: an apparatus to show the construction of major and minor diatonic scales, &c. (2) Modulaphone: an instrument for teaching the same. (3) Metrophone: an instrument to assist in teaching the divisions of time.

3807. **DENLEY, MISS MARY A.**, Fontenay, Endlesham Road, Balham, Surrey.—Design for ceiling of music room.

3808. **KORNATZKI, F. VON**, 8 Rutland Villas, Forest Hill, London, S.E.—Chord Denoters.

3809. **TUBBS, JAMES**, 94 Wardour Street, Oxford Street, London, W.—Violin, Viola, and Violoncello Bows of finest quality in gold and silver mountings.

3811. **STEELEY, FRANK**, 272 Camden Street, Birmingham. —Design for Pianoforte, with an arrangement for music books, &c.

3812. **LEXOW, A.**, 43 Presdener Strasse, Berlin (Agent, J. RIECK, 24

Oseney Crescent, Kentish Town, London, N.W.—Pianoforte Action Work.

3813. **HEUTELBECH, FRIEDR.**, Neunvade, Westfalen, Germany (Agent, J. RIECK, 24 Oseney Crescent, Kentish Town, London, N.W.).—Pianoforte Wrist Pins and Ironmongery.

3814. **FARMAN, EDGAR, M.S.A.**, 5 Great James Street, Bedford Row, London, W.C.—Design for an Organ, suitable for a cathedral or large church with a gallery below to support it.

3815. **SMITH, F.**, 11 Sutton Court Terrace, Turnham Green, London, S.W.—Design for Organ Case.

3816. **BLACK, WILLIAM S.**, 19 Queen Street, Edinburgh.—Top of Grand Pianoforte Case.

3817. **BUTTERTON, MISS MARY**, 62 South Lambeth Road, London, S.W.—Front of Piano in walnut wood, with inlaid china plaques.

3818. **ARDING, MISS E. A.**, 18 Sloane Square, London, S.W.—Design for back of a piano.

3819. **ALLOM, CHARLES C.**, 18 Batoum Gardens, West Kensington Park, London, W.—Designs for piano cases.

3820. **ADAMS, MRS. R. H.**, 28 Applegarth Road, Brook Green, London, W.—Original Design for Pianoforte Front.

3821. **ADAMS, MISS M. S.**, 156 Lambeth Road, London, S.E.—Design for front of pianoforte.

3822. **ADAMS, R. H.**, 28 Applegarth Road, Brook Green, London, W.—Original Design for pianoforte case.

3823. **MCDONALD, MISSES A. & H.**, 88 Lansdowne Road, Kensington Park, London, W.—Embroidered Frontal for piano.

3824. **NOBLE, HENRY**, 2 Dean Road, Willesden, London, N.W.—Designs for pianoforte cases.

3825. **QUILLER-LANE, RICHARD**, Inverary Cottage, Sydenham, Belfast.—Design for pianoforte case, full compass, carved and inlaid in the Italian style.

3826. **MORDRET, L. E.**, Rugénieur rue St. François, or Louviers, Eure, France.—Drawings of Violins and Pamphlets on String Instruments.

3827. **HON. ARTILLERY CO.,** Armoury House, Finsbury, London, E.C.—Drums and Musical Instruments, with Trophy of Arms and Regimental Colours.

3828. **MACFARLANE & WALLACE,** Decorative Artists, 27 Queensferry Street, Edinburgh.—Design for a chamber concert room.

3829. **TROMBA, M. I.,** 64 St. George's Road, Tufnell Park Road, London, N.—Musical Reeds.

ADLEY, J., & CO., 47 Lisimore Road, Haverstock Hill, London, N.W.—(1) Musical Diagrams used for class purposes. (2) Printing Machines. (3) Stereo and Electro Plates, Type, &c. (4) Intonators. A monochord of peculiar construction serving as a model of just intonation.

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PARIS, 1878.—Prize Medal for "Great Excellence combined with Moderate Cost."

MELBOURNE, 1881.—Gold Medal for "Excellence of Quality combined with Solidity of Construction."

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GROUP XXXIII.—MUSIC ENGRAVING AND PRINTING.

CLASS CLXXVIII.

Printed and Engraved Music: and Machines and Appliances for its Production.

3846. HOME, ROBERT, & SON, 11 Greenside Lane, Edinburgh.—(1) Books, &c., illustrating music engraving and printing. (2) Specimens of Sheet Music from engraved and stereotype plates. (3) Music Titles, &c., engraved and lithographed.

3847. ADLEY & CO., 47 Lisimore Road, London, N.W.—(1) Music Printing. (2) Printing Machine. (3) Stereo and Electro Plates, Type, &c.

3848. CURWEN, J., & SONS, 8 Warwick Lane, London, E.C.—(1) Specimens of Music Printing. (2) Type Metal Plates, &c. (3) Printed Sheets and Books of Music as used in teaching singing-at-sight from both staff and tonic sol-fa notations.

3849. BONNARD, PAUL, 49 Rue de Grenelle, St. Germain, Paris.—New Method of Musical Notation.

3850. AUGENER & CO., 86 Newgate Street, London, E.C.—(1) Printed Music Volumes. (2) Educational Music, Portraits.

3851. BRITISH & FOREIGN BLIND ASSOCIATION, 33 Cambridge Square, London, W.—(1) Music Embossed for the use of the Blind, Braille system. (2) Stereo Plates for producing the same. (3) Frame for enabling the blind to write music, Braille system. (4) Musical Characters used by the seeing in relief for the use of the blind who are teaching seeing pupils.

3852. MORLEY, W., & CO., 269 Regent Street, W.; and 70 Upper Street, London, N.—(1) New Songs printed from engraved plates. (2) Musical Works printed from type and engraved plates. (3) Copy of David Baptie's Musical Biography.

3853. RAWKINS & PERCY, Moor-gate Station Arcade, 26 Moorfields, London, E.C.—(1) Printed and Engraved Music. (2) Designs for Music Titles. (3) Portable Music Cases and Carriers.

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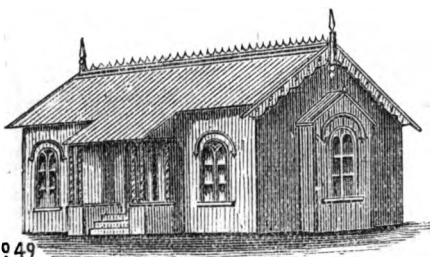
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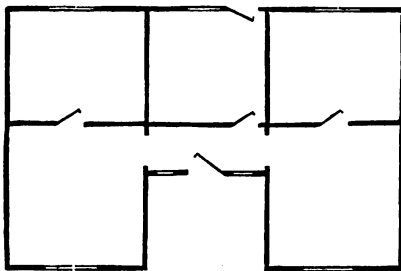
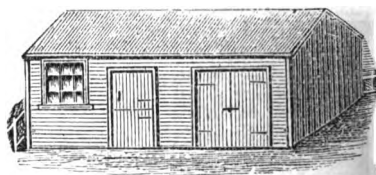
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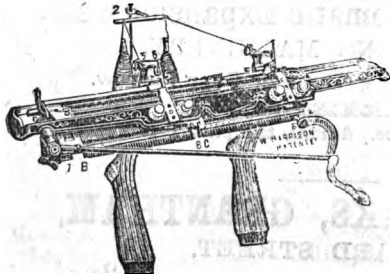
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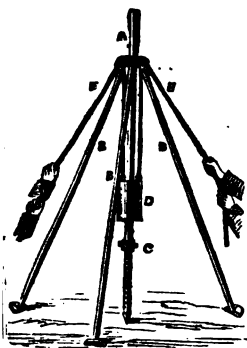
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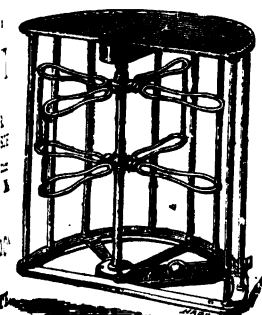


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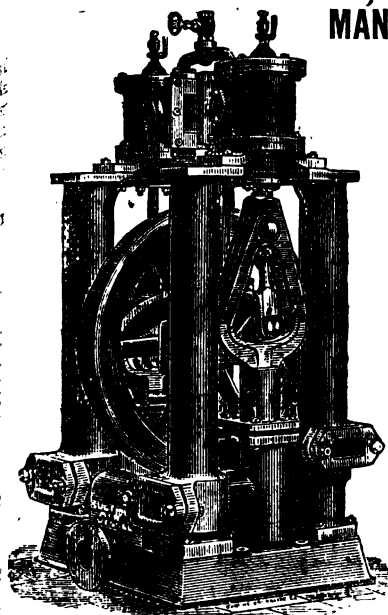
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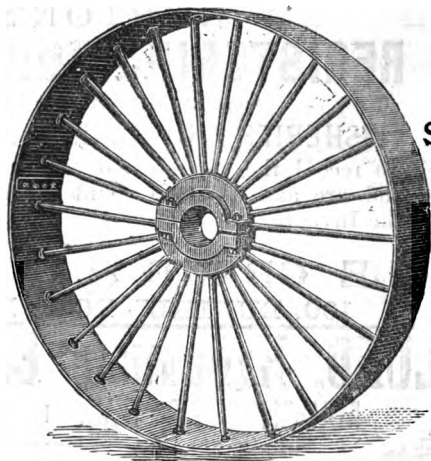
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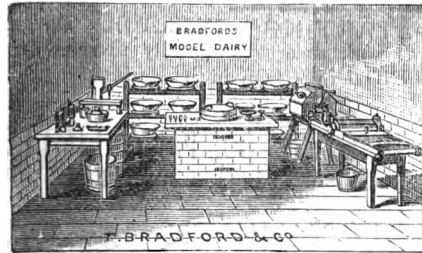
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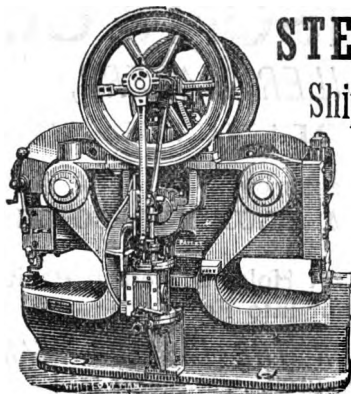
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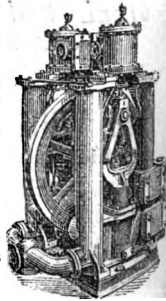
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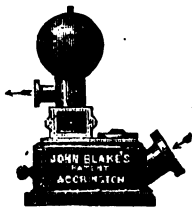


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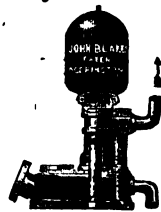
No Cost for Motive Power, which is obtained from the Stream of Water passing through the Rams.



This Ram raises a portion of the water by which it is driven.



View of Ram worked by water from a spring, and supplying the house and garden on the hill.



This Ram will force up spring water whilst worked by impure water.

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The Delivery Pipe, in the above case, is 9,000 feet in length.

From Mr. HENRY ROBINSON, Engineer to the Stockport District Waterworks Co., September 8, 1883.—“Dear Sir,—I can now report well of the two Hydraulic Rams we have fixed to your instructions for the supply of Disley Village; 40,000 gallons per day was the quantity you promised they would force to a height of 68 feet, but on testing them I am convinced that 50,000 gallons is not the limit of their power, whilst the quantity of waste water used in driving them is not equal to half the capacity of the 6-inch pipe by which they are fed, and I am inclined to the belief that a more simple and efficient pump cannot be found.”

From Mr. E. W. STREETER, F.R.G.S., Diamond Merchant, Bond Street, London, and Sackville Park, Sussex, October 1st, 1883.—“Dear Sir,—When you surveyed the site at Sackville Park, Buxted, for the purpose of fixing a Ram with one mile of collecting and distributing mains, I was surprised and pleased when you named the quantity of water you could send up from the resources available. My bailiff prepared the ground to your instructions, and in 12 days from the arrival of your men, the Ram was in operation, sending up 20 per cent. more water than you promised to a height of 110 feet, and distributing a supply to a farm and several cottages on the way. I have pleasure in recording my entire approval of the work.”

From Captain TOWNSHEND, Wincham, February 10, 1877.—“In answer to your inquiry I am glad to say the Hydraulic Ram you sent me in November, 1875, is working exceedingly well, and gives no trouble. It will work when quite immersed, as it has been several times during this winter, forcing up water through a delivery pipe 900 yards long at the rate of 80,000 gallons per day, although you only promised 50,000.”

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 „ His Grace the Duke of Portland.
 „ The Most Noble the Marquis of Downshire.
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 „ The Rev. Hon. E. T. St. John, Bletsoe, Bedford.
 „ Admiral Sir George Broke-Middleton, Broke Hall.
 „ Major-Gen. Sir Henry Marham Havelock-Allan, Bt.
 „ Major-Gen. Fielden, Wotton Park, Blackburn.
 „ Gen. Gerard Potter Eaton, The Pole, Cheshire.
 „ Sir Henry A. Hoare, Bart., Stourhead, Bath.
 „ Sir William Fielding, Bart., Feniscowles, Blackburn.
 „ Sir Robert Menzies, Bart., of Menzies.
 „ Sir Humphrey De Trafford, Bart., Trafford Park.
 „ Sir Michael Robert Shaw-Stewart, Bart.
 „ Sir Henry W. Ripley, Bart., Acacia, near Leeds.

JOHN BLAKE, ENGINEER, ACCRINGTON, LANCASHIRE, ENGLAND.

JAS. FARMER & SONS,

MACHINISTS, MILLWRIGHTS, AND ENGINEERS,

ADELPHI STREET, SALFORD, MANCHESTER.

MAKERS OF STEAM ENGINES.

High or Low Pressure, and either Vertical, Horizontal, or Diagonal.

BLEACHING AND FINISHING MACHINERY.

Singeing Stoves, high and low pressure Bowking Kets, Beater and Roller Washing Machines, PATENT (FARMER AND LALANCE) WASHING, SOAPING, DYEING and BOILING RANGES; Chemic and Sour Pumps, Squeezing Machines, Scutchers or Openers, Water Mangles, Starch Mangles, with or without friction; Back Searching Machines, Lime Mixing Machines, Strap Stretching Machines, Damping Machines, Drying Stoves and Hanging Machines, every description of CALENDERS, including those for such purposes as Friction and Swissing—universal for various finishes, Chasing, Moiré Lustre, and for Chucking, Jacking, Embossing, &c. Chloring Ranges, Drying Machines, with either Copper or Tin Cylinders arranged horizontally or vertically; Drying Machines combined with Starch or other Mangles, for various purposes, and driven by variable friction driving; Improved cast-iron Drying Cylinders constructed from 14 to 20 feet diameter, for drying on one side only; Felling Stocks, Steaming Cottages, Rolling and Lapping Machines, Brush Canroys from 1 to 8 Brushes; CALICO PRINTING MACHINES, Improved Beetling Machines, (Beetle Faller, Planing and Morticing Machines); Brass and Cast-iron Revolving Expanding Rollers, Doubling or Creasing and Measuring Machines, with Patent Marker; Warp Sizing and Drying Machines combined, Warp Baling Machines.

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Arranged to Stretch either with Pins or Clips.

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Comprising Cork Grinding, Pugging, Mixing, &c., Machines; STRONG LINOLEUM CALENDERS, for making Linoleum 2 or 4 yards wide; also Stove Fittings.

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FOR CONICAL SPOOLS ON PAPER TUBES.

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R. BROADBENT & SON, Machinists, STALYBRIDGE.

PATENT

"GRIP" BELT FASTENER,

FOR JOINING MACHINERY BANDS WITHOUT HOLING.

INSTANTANEOUS in Adjustment. PERFECT in Operation.

SEE MACHINES AT WORK IN
GROUP IX.

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PATENT

LOOSE BOSS TOP ROLLERS.

SEE
GROUP
IX.

ROBERT BROADBENT & SON, STALYBRIDGE.

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Fitted with the only positive Drawback Motion and all Latest Improvements.

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EVERY DESCRIPTION OF HIGH-CLASS KEYLESS AND ORDINARY WATCHES,

105, LIVERPOOL ROAD, LONDON, N.

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HONOUR (HIGHEST AWARDS), and the FIRST PRIZE, with the
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These Prizes being obtainable Once Only.

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540 competing Chronometers.

At the Sydney Exhibition, 1880, two first-class Awards were obtained; and although the
Watches were not expected to be entered for competitive trial, they obtained, at the Govern-
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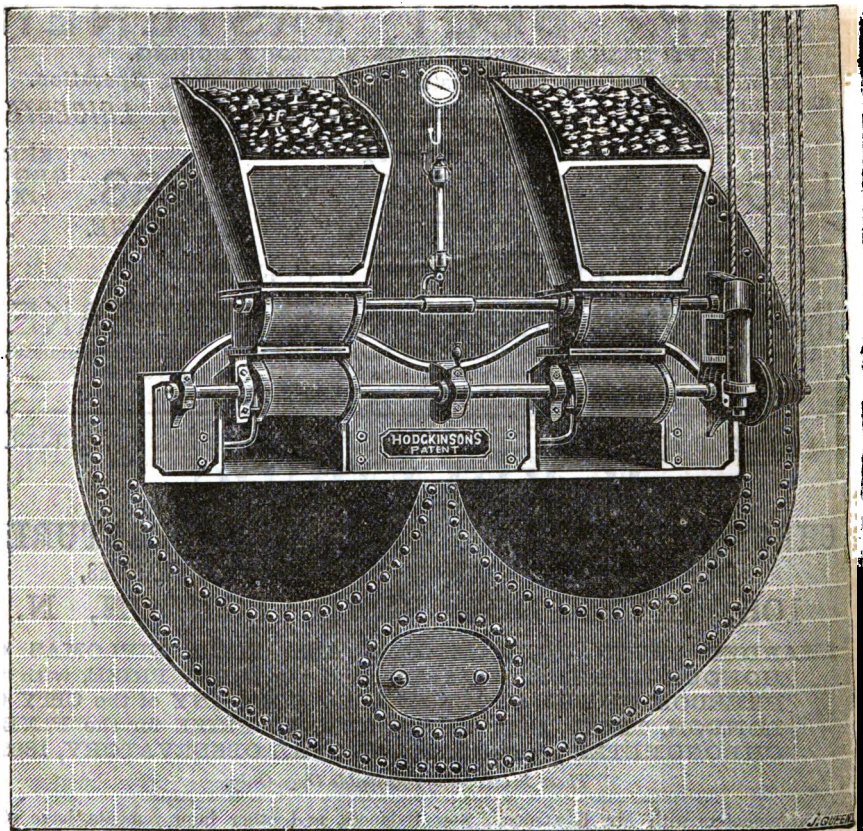
Mr. GILL, now Astronomer-Royal at the Cape, writes — "Of the 50 chronometers used
Kullberg's has, on the whole, performed best. Allow me to express the great satisfaction
I have had in all the chronometers of your make in the expedition to Mauritius" (Lord
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WITH OR WITHOUT
SELF-CLEANING FIRE BARS.
THE SIMPLEST. THE CHEAPEST. THE BEST.



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WODEN STREET, SALFORD, MANCHESTER.
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VACUUM AUTOMATIC BRAKES.

MILEAGE RUN WITH CONTINUOUS BRAKES

(PRESSURE AND VACUUM)

DURING THE HALF-YEAR ENDING 30th JUNE, 1884.

Extracted from the BOARD OF TRADE Returns.

WESTINGHOUSE (Automatic and Non-Automatic)	..	..	..	..	..	16,180,482
VACUUM	..	..	..	..	..	22,120,998
Total number of FAULTS, DELAYS, &c., with Westinghouse Brakes	..	..	..	..	..	897
" " " Vacuum	..	..	..	..	..	146

THIS SHOWS FOR

WESTINGHOUSE, 1 Fault per 40,630 miles run. VACUUM, 1 Fault per 151,513 miles run.

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Engineer, ALFRED L. SACRÉ.

THE POLYCHROMATIC

SIMULTANEOUS PRINTING COMPANY, LIMD.,

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TAPESTRIES ANCIENT and MODERN, IMITATION.

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VELVETS. PLUSHES. SILKS, &c. INDIA-RUBBER, JUTES, &c.

Group 26. Stand 2030. East Gallery.

"SCANDINAVIA"

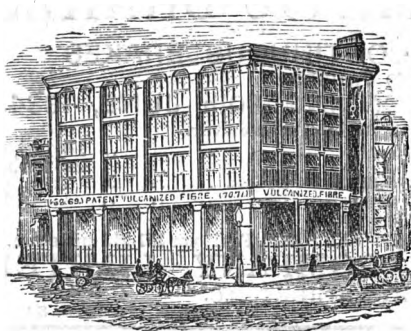
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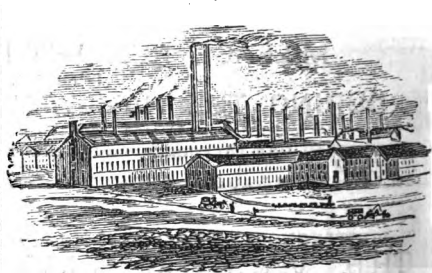
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82, Southwark Street, London, S.E.

Exhibit No. 488. South Gallery, Middle Court.

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FACTORY.

THIS new Material is supplied in two qualities Flexible and Hard.

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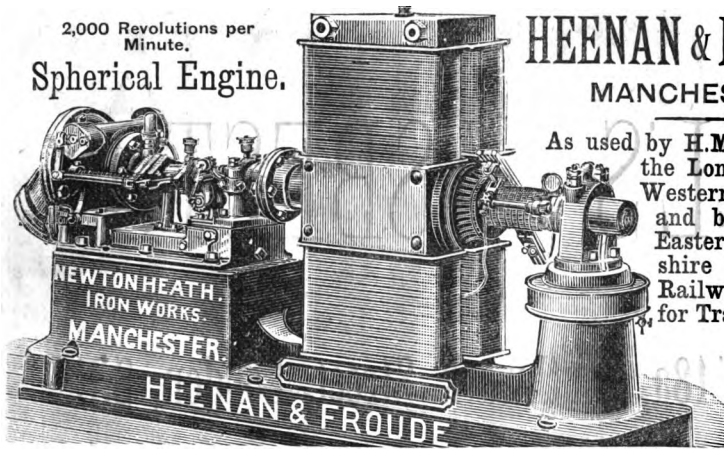
It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds is unequalled.

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Sold in Sheets 66 inches by 42 inches, varying in thickness from $\frac{1}{16}$ to 1 inch.

Flexible Red, 2s. per lb.; Hard Gray or Red, 2s. 3d. per lb.; Hard Black, 2s. 10d. per lb.

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68, 69, 70, 71, CHISWELL STREET, LONDON, E.C.



2,000 Revolutions per Minute.
Spherical Engine.

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MANCHESTER.

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SEE
Stall 423.
Group 4.

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On which Ropes can be made of any Length or of any Thickness.

THE "JAMES" PATENT DOUBLING AND LAYING MACHINE
For making all kinds of Cord, Twine, &c., of any spun material as, Gold, Silk, Cotton, Linen, Hemp, Worsted, Asbestos, &c.

RILEY'S PATENT PISTON RING.
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And Steam Boiler and Steam Engine Fittings in General.

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Group IV.

Stand No. 427.

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A REAL MUSICAL TREASURE.



This CHARMING INSTRUMENT performs every description of Music for PSALM, SONG, MARCH, or DANCE.

It plays thousands of tunes, *there is no limit to the number.*

It requires no knowledge of Music on the part of the player, and can therefore be played by ANYONE, *even a child.* It is very suitable for a present.

The TONE is exceedingly rich and pleasing, blending beautifully with the voice in SINGING.

The AUREPHONE is *cheap* enough for the poor man's cottage, and *good* enough to adorn the dwellings of the rich.

The AUREPHONE will "*drive dull care away,*" induce cheerfulness, and help to make HOME HAPPY.

Price, packed in strong deal box, including One Roll of Music, £3 3s.

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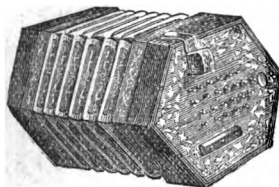
143, HOLBORN BARS, LONDON, E.C.

(CORNER OF BROOKE STREET).

International Inventions Exhibition, East Central Gallery. Group XXXII.
Stand No. 3871.

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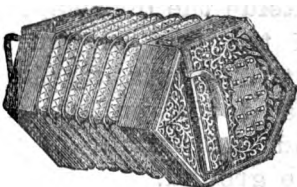
LONDON,
1862.

PARIS,
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SYDNEY,
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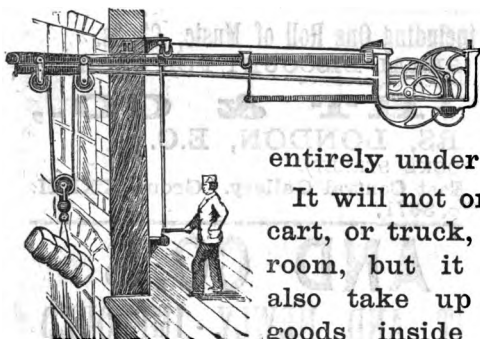
LITTLE JAMES STREET, GRAY'S INN ROAD, LONDON, W.C.

West Annexe. Group II. Stand 1246.

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Park Street Iron Works, Oldham, England.

BARKER'S PATENT SELF-LANDING AND SELF-DELIVERING HOIST.



**Barker's Patent Self-Landing
and Self-Delivering Hoist.**

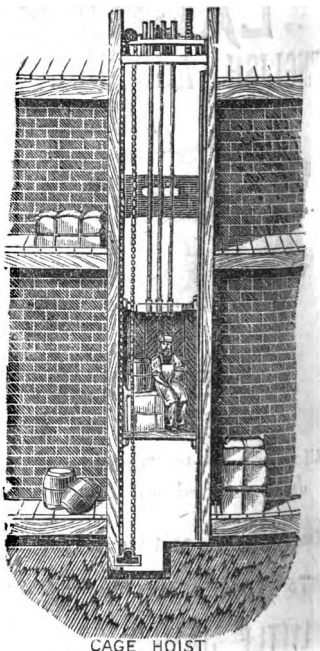
entirely under the control of one man. It will not only lift the goods from the cart, or truck, and take them inside the room, but it will also take up the goods inside the room, travel them outside the doorway, and lower them on the cart or truck as required, entirely obviating the risk of having the goods pulled off the doorstep, and the danger of their falling to the ground.

**GOODS OR PASSENGER LIFT,
FITTED WITH BARKER'S PATENT AUTOMATIC SAFETY
DOORS.**

(A Model of which is Exhibited.)

This apparatus completely takes out of the care of the attendant the means of guarding the Well-hole of Hoist or Lift, the hoist box or cage itself opening and closing the door or barrier at every floor or landing.

**ALSO MAKERS OF FRICTION HOISTS,
TRAVELLING CRANES, &c.**



CAGE HOIST

GREENWOOD & BATLEY,

ALBION WORKS,

LEEDS, ENGLAND,

INVITE ATTENTION TO THEIR EXHIBITS.

In Group 4, South Gallery, Middle Court, Stand No. 417.

ARMINGTON & SIM'S PATENT ENGINE,
of which they are the Sole Makers.

In Group 26, East Gallery, Stand No. 1987.

PATENT CONTINUOUS WEB PLATEN PRINTING MACHINE.

In Group 10, West Gallery, Stand No. 1132.

Improved and Patented Machinery for making and maintaining
MILLING CUTTERS, TWIST DRILLS, &c., also
SCREW MAKING and BEVEL WHEEL CUTTING MACHINERY.

Stand No. 1132.

PATENT EMERY GRINDING WHEELS.

GREENWOOD & BATLEY,

ALBION WORKS, LEEDS,

MANUFACTURERS OF

SELF-ACTING TOOLS, &c.

for Engineers, Machine Makers, and Special
Purposes.

PATENT BOLT & NUT MACHINERY.
Machinery for Silk, China Grass, and other Fibres.
Special Machinery for the manufacture of Ordnance Small
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For Engineers, Sewing Machine, Lock and Scale Makers, and all purposes where great STRENGTH, DURABILITY, and PERFECT FLEXIBILITY are required. In Sheets and Rolls.

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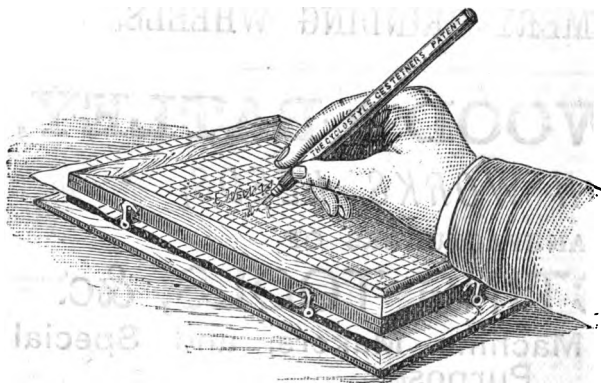
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THE CYCLOSTYLE (Gestetner's Patent).



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All information, and Forms for Applications, &c., may be obtained in the East Gallery, at Stand No. 287, of Mr. Newnham Browne, Patent Agent, and at 73, Cheapside, E.C.

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THE MOST SUITABLE FLOORING FOR HOSPITALS, LIBRARIES, BANKS, HOTELS, SCHOOLS, CHURCHES, PUBLIC BUILDINGS, PRIVATE RESIDENCES, ETC.

Proof against Dampness and Dry Rot. Perfectly Noiseless. Warm and Dry, and far more Durable than ordinary Flooring. Being laid Solid on a Concrete Foundation, there is no space under this Flooring for Foul Air or Vermin to accumulate. A Special Feature in this Patent System is that the Blocks are firmly secured by an adhesive and preservative composition; and are also "keyed" to the Composition and the underlying Cement Bed by Metal Keys; it is therefore impossible for the Blocks to become loose. Can be laid to any Design similar to Parquetry; and in any kind of Wood.

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WILLIAM CROSLAND,

NEW STREET, MILES PLATTING, MANCHESTER.

MANUFACTURER OF

THE "ADVANCE"

SELF-CLAMP PAPER CUTTING MACHINE, AND ALL MACHINES USED BY FANCY BOX MAKERS.

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This New White Lead Paint possesses the following important advantages:—It is Perfectly Innocuous—It will always Retain its Colour—It is superior in Body, Colour, Density, and Durability to White Lead manufactured by the ordinary methods—It mixes more readily with Oil, and is Entirely Free from the Injurious Smell of Poisonous White Lead.

Patentees and Sole Manufacturers:—

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WHITE LEAD, VARNISH, AND COLOUR MANUFACTURERS,

Samples and Prices] GROVE WORKS, BATTERSEA, LONDON. [on application.

SILOS F. W. REYNOLDS & CO.,
ENGINEERS.
ACORN WORKS, EDWARD STREET, BLACKFRIARS, LONDON, S.E.
Patent Mechanical Pressure, for Silage in Silos or Stacks.
Also Patent Portable Wooden Silos.

DRAWINGS AND PRICES ON APPLICATION.

2 D 2

BRADLEY'S PATENT ROLLER LOCKS AND LATCHES

For **RAILWAY-CARRIAGE, SAFES, and other Doors.**

See Exhibits in **SOUTH GALLERY, (MIDDLE COURT) GROUP V. No. 255.**

Address: WILLIAM BRADLEY, Inventor and Patentee.

18, COLLEGIATE CRESCENT, BROOMHALL PARK, SHEFFIELD.

PATENTS FOR INVENTIONS, DESIGNS, AND TRADE MARKS.

HART & CO.,

PATENT AGENTS. ESTABLISHED 1860.

186, FLEET STREET, LONDON, E.C.

Handbook Free on Application.

THE CELEBRATED



Is famed throughout the world for sharpening edge tools, from the Razor to the Joiner's Plane Irons, different grades of quality being selected to meet these requirements. It requires no oil. Sharpen with water; puts on a keen sharp edge. Cut in Hones for razors, medical instruments, penknives, plane irons, hedge knives, axes, sheep shears, &c., &c. Honourable Mention Paris International Exhibition 1878, and Diploma of Bronze Medal London International Exhibition, 1884. Ask your Ironmonger or other retail house to get you one, and give my address. If he won't, write direct—**JOHN C. MONTGOMERIE, "Tam O'Shanter Stone" Hone Works, Dalmore, Stair, Tarbolton Station, R.S.O., Ayrshire.**

PATENTS FOR INVENTIONS.

(British, Foreign, and Colonial.)

THE REGISTRATION OF DESIGNS AND TRADE MARKS.

Apply to MR. ERNEST DE PASS,

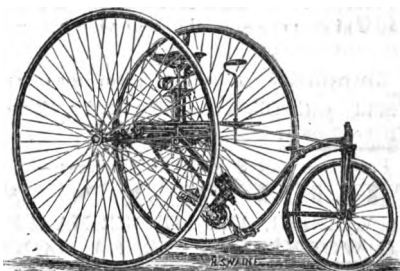
Fel. Inst. Patent Agents, Assoc. Soc. Engineers, Foreign Member of the Syndicat des Ingénieurs et Conseils de France, en matière de Propriété Industrielle.

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PATENT

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JOSEPH BERNAYS, C.E., CONSULTING AND GENERAL ENGINEER,
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NEW PATENT STEAM PUMPS shown at work in the West Annexe,
Group XI. Stand No. 1233.

PATENT TWIN CYLINDER STEAM ENGINES for Marine or Stationary purposes.
IMPROVED CENTRIFUGAL PUMPS of all sizes.

FOR PRICES AND PARTICULARS APPLY AS ABOVE.

PATENTS.

British and Foreign Patents
procured and advice given re
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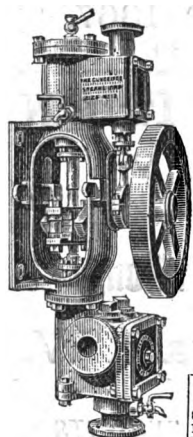
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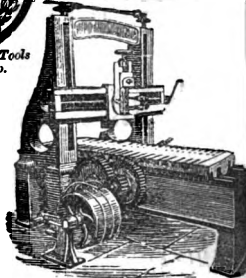
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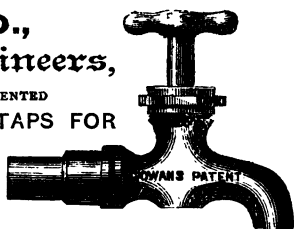
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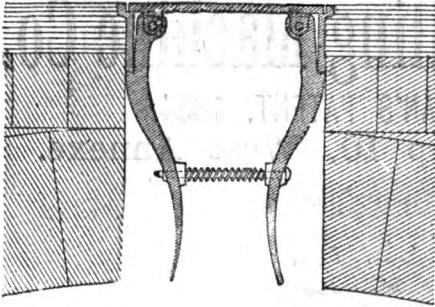
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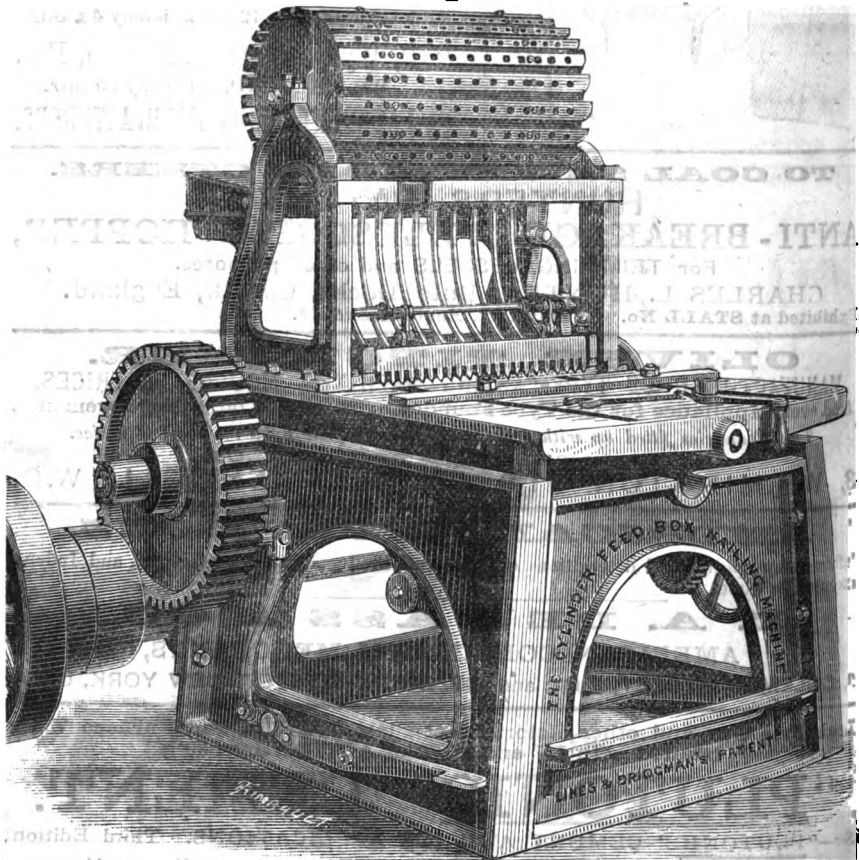
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